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Horſe-Hoeing Husbandry:

O R,

An ESSAY on the PRINCIPLES

O F

Vegetation *and* Tillage.

Deſigned to introduce

A NEW METHOD of CULTURE;

WHEREBY

The Produce of Land will be increaſed, and the
uſual Expence leſſened.

Together with

Accurate DESCRIPTIONS and CUTS of the Inſtruments
employed in it.

By JETHRO TULL, *Eſq;*
Of Shalborne *in* Berkſhire.

The THIRD EDITION, very carefully Corrected.

To which is prefixed,

A New PREFACE by the EDITORS, addreſſed to all
concerned in AGRICULTURE.

LONDON:
Printed for A. MILLAR, oppoſite to *Catharine-ſtreet*
in the *Strand*,
M.DCC.LI.

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THE
PREFACE.

AS Mr. *Tull's* Eſſay on *Horſe-Hoeing Huſbandry* has been publiſhed ſome Years, it may be preſumed that the World hath by this time formed ſome Judgment of his Performance; which renders it the leſs neceſſary for the Editors of this Impreſſion to ſay much concerning it. For every Man who has attended to the Subject, and duly conſidered the Principles upon which our Author's Method of Culture is founded, is an equal Judge how far his Theory is agreeable to Nature: Though it is but too true, that few have made ſufficient Experiments to be fully informed of it's Worth.

How it has happened, that a Method of Culture, which propoſes ſuch Advantages to thoſe who ſhall duly proſecute it, hath been ſo long neglected in this Country, may be matter of Surprize to ſuch as are not acquainted with the Characters of the Men on whom the Practice thereof depends; but to thoſe who know them thoroughly it can be none. For it is certain that very few of them can be prevailed on to alter their uſual Methods upon any Conſideration; though they are convinced that their continuing therein diſables them from paying their Rents, and maintaining their Families.

And, what is ſtill more to be lamented, theſe People are ſo much attached to their old Cuſtoms, that they are not only averſe to alter them themſelves, but are moreover induſtrious to prevent others from ſucceeding, who attempt to introduce any thing new; and indeed have it too generally in their Power, to defeat any Scheme which is not agreeable to their own Notions; ſeeing it muſt be executed by the ſame Sort of Hands.

This naturally accounts for Mr. *Tull*'s Huſbandry having been ſo little practiſed. But as the Methods commonly uſed, together with the mean Price of Grain for ſome Years paſt, have brought the Farmers every-where ſo low, that they pay their Rents very ill, and in many Places have thrown up their Farms; the Cure of theſe Evils is certainly an Object worthy of the public Attention: For if the Proprietor muſt be reduced to cultivate his own Lands, which cannot be done but by the Hands of theſe indocile People, it is eaſy to gueſs on which Side his Balance of Profit and Loſs will turn.

This Conſideration, together with many others which might be enumerated, hath induced the Editors to recommend this Treatiſe once more to the ſerious Attention of every one who wiſhes well to his Country; in hopes that ſome may be prevailed upon, by regard either to the public Good or their own private Intereſt, to give the Method here propoſed a fair and impartial Trial: For could it be introduced into ſeveral Parts of this Country by Men of generous Principles, their Example might, in time, eſtabliſh the Practice thereof, and bring it into general Uſe; which is not to be expected by any other means.

It is therefore to ſuch only, as are qualified to judge of a Theory from the Principles on which it is founded, that the Editors addreſs themſelves, deſiring they will give this Eſſay another Reading with due Attention: and at the ſame time they beg leave to remind them how unfit the common Practiſers of Huſbandry are to paſs Judgment, either on the Theory or Practice of this Method; for which Reaſon it is hoped that none will be influenced by ſuch, but try the Experiment themſelves with proper Care.

As a Motive to this it is to be obſerved that, although the Method of Culture here propoſed has made little Progreſs in *England*, it is not like to meet with the ſame Neglect abroad, eſpecially in *France*; where a Tranſlation of Mr. *Tull's* Book was undertaken, at one and the ſame time, by three different Perſons of Conſideration, without the Privity of each other: But afterwards, Two of them put their Papers into the Hands of the Third, Mr. *Du Hamel du Monceau*, of the *Royal Academy of Sciences* at *Paris*, and of the *Royal Society* at *London*; who has publiſhed a Book intituled, *A Trea-*

tiſe of Tillage, on the Principles of Mr. Tull. The ingenious Author has indeed altered the Method obſerved by Mr. *Tull* in his Book; yet has very exactly given his Principles and Rules: But as he had only ſeen the Firſt Edition of the *Horſe-Hoeing Husbandry*, ſo he is very defective in his Deſcriptions of the Ploughs and Drills, which in that were very imperfect, and were afterwards amended by Mr. *Tull* in his Additions to that Eſſay.

One of our principal Reaſons for taking Notice of this Book is, to ſhew the Compariſon this Author has made between the Old Method of Huſbandry and the New. By his Calculation the Profits ariſing from the New, are conſiderably more than double thoſe of the Old. For, according to him, the Profits of Twenty Acres of Land for Ten Years, amount, at 10*d.* ½ *per* Livre,

	l.	*s.*	*d.*	
By the Old Method, to 3000 Livres, or	131	5	0	*Sterling.*
By the New Method, to 7650 Livres, or	334	13	9	

which makes a prodigious Difference in favour of the latter. As this Computation was made by one who cannot be ſuppoſed to have any Prejudice in favour of Mr. *Tull*'s Scheme, it will naturally find more Credit with the Public than any Compariſon made by Mr. *Tull* himſelf, or by ſuch as may have an Attachment to his Principles.

It may probably be expected, that the Editors ſhould take Notice of ſuch Objections as have been made, either to Mr. *Tull*'s Theory or Practice; but we do not know any that in the leaſt affect his Principles: They ſtand uncontroverted: Nor are there any to the Practice, which may not be equally urged againſt every Sort of Improvement. One of the principal which have come to our Knowlege is, it's being impracticable in common Fields, which make a great Part of this Country, without the Concurrence of every one who occupies Land in the ſame Field. But doth not this equally affect the Old Huſbandry? For every ſuch Perſon is obliged to keep the Turns of plowing, fallowing, *&c.* with the other Occupiers; ſo that if any of them were inclinable to improve their Lands, by ſowing Graſs-ſeeds, or any other Method of Culture, they are now under the ſame Difficulties as they would be, were they to practiſe Mr. *Tull*'s Method. Therefore this is rather to be lamented as a public Misfortune, than to be brought as an Objection to the Practicableneſs of that Method. Others object, that the introducing this Sort of Huſbandry is unneceſſary, ſeeing the Improvements which are made by Graſs-ſeeds are ſo conſiderable; beſides, that the Returns made by the Fold and the Dairy, being much quicker than thoſe of Grain, engage the Farmer to mix Plowing and Grazing together. But when this is duly conſidered it can have no ſort of Weight: for is it not well known that, in thoſe Farms where the greateſt

Improvements have been made by Graſs-ſeeds, the Quantity of Dreſſing required for the Arable Land often runs away with moſt of the Profit of the whole Farm? eſpecially when the Price of Grain is low. And if this be the Situation of the moſt improved Farms, what muſt be the Caſe of thoſe which chiefly conſiſt of Arable Land; where moſt of the Dreſſing muſt be purchaſed at a great Price, and often fetched from a conſiderable Diſtance? Add to this the great Expence of Servants and Horſes, unavoidable in Arable Farms; and it will appear how great the Advantages are which the Graſier hath over the plowing Farmer. So that it is much to be wiſhed, the Practice of mixing the Two Sorts of Huſbandry were more generally uſed in every Part of the Kingdom; which would be far from rendering Mr. *Tull*'s Method of Culture uſeleſs; ſeeing that, when it is well underſtood, it will be found the ſureſt Method to improve both.

For although Mr. *Tull* chiefly confined the Practice of his Method to the Production of Grain (which is a great Pity), yet it may be extended to every Vegetable which is the Object of Culture in the Fields, Gardens, Woods, *&c.* and perhaps may be applied to many other Crops, to equal, if not greater Advantage, than to Corn.

In the Vineyard it has been long practiſed with Succeſs; and may be uſed in the Hop-

Ground with no leſs Advantage. For the Culture of Beans, Peas, Woad, Madder, and other large-growing Vegetables; as alſo for Lucern, Saintfoin, and the larger Graſſes; we dare venture to pronounce it the only Method of Culture for Profit to the Farmer; ſeeing that, in all theſe Crops, one Sixth Part of the Seeds now commonly ſown will be ſufficient for the ſame Quantity of Land, and the Crop in Return will be much greater; which, when the Expence of Seeds is duly conſidered, will be found no ſmall Saving to the Farmer.

Nor ſhould this Method of Culture be confined to *Europe*: for it may be practiſed to as great Advantage in the *Britiſh* Colonies in *America*, where, in the Culture of the Sugar-Cane, Indigo, Cotton, Rice, and almoſt all the Crops of that Country, it will certainly ſave a great Expence of Labour, and improve the Growth of every Plant, more than can be imagined by ſuch as are ignorant of the Benefit ariſing from this Culture. And ſhould the Subjects of *Great Britain* neglect to introduce this Method into her Colonies, it may be preſumed our Neighbours will take care not to *be blameable on this Head*; for they ſeem to be as intent upon extending every Branch of Trade, and making the greateſt Improvements of their Land, as we are indifferent to both: So that, unleſs a contrary Spirit be ſoon exerted, the Balance of Trade, Power, and every other Advantage, muſt be againſt us.

There have been Objections made by ſome to Mr. *Tull*'s Method, as if it were practicable only on ſuch Lands as are ſoft and light, and not at all on ſtiff or ſtony Ground. That it hath not been practiſed on either of theſe Lands in *England* we are willing to grant; but we muſt not from thence infer that is impoſſible to apply it to them. For the Hoe-Plough has been very long uſed in the Vineyards in many Countries, where the Soil is ſtronger, and abounds with Stones full as much as any Part of this Country. However, though the Uſe of this Plough may be attended with ſome Difficulties upon ſuch Land, for Wheat, or Plants of low Growth, whoſe Roots may be in Danger of being turned out of the Ground, or their Tops buried by the Clods or Stones; yet none of the larger-growing Plants are ſubject to the ſame Inconveniencies. Beſides, the ſtronger the Soil is, the more Benefit will it receive from this Method of Culture, if the Land be thereby more pulverized; which will certainly be the Conſequence, where the Method laid down by Mr. *Tull* is duly obſerved.

But as moſt Inſtruments, in their Firſt Uſe, are attended with ſome Difficulty, eſpecially in the Hands of ſuch as are indocile, the Hoe-plough has been complained of, as cumberſome and unwieldy to the Horſe and Ploughman. But perhaps this ariſes chiefly from the Unwillingneſs of the Workmen to introduce any new Inſtrument:

Indeed, ſeeing little is to be expected from thoſe who have been long attached to different Methods, the ſureſt Way to promote the Uſe of it, is to engage young Perſons, who may probably be better diſpoſed, to make the Trial at their firſt entering into Buſineſs; and then a little Uſe will make it eaſy. It is proper to obſerve here, that the Swing-plough, which is commonly uſed in the deep Land about *London*, will do the Buſineſs of the Hoe-plough in all Ground that is not very ſtrong, or very ſtony; and that where it is ſo, the Foot-plough, made proportionably ſtrong, will completely anſwer all Purpoſes. But it muſt be remembered, that when theſe are uſed to hoe Corn, the Board on the Left Hand of the Plough, anſwering the Mould-Board, muſt be taken off; otherwiſe ſo much Earth will run to the Left Side, as to injure the Crop when it is low.

The *Drills* are excellent Inſtruments; yet we imagine them capable of ſome farther Improvement. Parallel Grooves, at about an Inch aſunder, round the Inſide of the Hopper, would ſhew the Man who follows the Drill, whether or no both Boxes vent the Seed equally. By an Hitch from the Plank to the Harrow, the latter may be lifted to a proper Heighth, ſo as not to be in the Way when the Ploughman turns at the Headland. Two light Handles on the Plank, like thoſe of the common Plough, would enable the Perſon who follows the Drill to keep it from falling off the Middle of the Ridge. It may alſo be uſeful, in wet Weather, to double the Drills; by which means Two Ridges may be ſown at the ſame time, the Horſe going between them: For the Planks of Two Drills, each Plank having one of the Shafts fixed to it, may be joined End for End by Two flat Bars of Iron, one on each Side, well ſecured by Iron Pins and Screws; and, by correſponding Holes in the Planks and Bars, the Diſtance between the Drills may be altered, according to the different Spaces between the Ridges.

The Alterations made by the Editors of this Impreſſion are little more than omitting the controverſial Parts of the Book, which were judged of no Service to the Reader, as they no-ways affected the Merits of Mr. *Tull*'s Principles.

But as he endeavoured to recommend his Theory by drawing a Compariſon between the Old Method of Culture and the New, ſo we beg leave to annex a Computation of the Expence and Profit of each; for which we are obliged to a Gentleman, who for ſome Years practiſed both, in a Country where the Soil was of the ſame Nature with that from whence Mr. *Tull* drew his Obſervations, *viz.* light and chalky. And we chuſe to give this the rather, as it comes from one who has no Attachment to Mr. *Tull*'s Method, farther than that he found it anſwer in his Trials. We appeal to Experience, whether every Article in this Calculation is not eſtimated in favour of the Common Huſbandry; whether the Expence be not rated lower than moſt Farmers find it, and the Crop ſuch as they would rejoice to ſee, but ſeldom do, in the Country where this Computation was made.

In the New Huſbandry every Article is put at it's full Value, and the Crop of each Year is Four Buſhels ſhort of the other; tho', in ſeveral Years Experience, it has equalled, and generally exceeded, thoſe of the Neighbourhood in the Old Way.

An Eſtimate of the Expence and Profit of Ten Acres of Land in Twenty Years.

I. *In the Old Way.*

Firſt Year, for Wheat, coſts 33 *l.* 5 *s.* *viz.*	*l.*	*s.*	*d.*	*l.*	*s.*	*d.*
Firſt Plowing, at 6 *s.* *per* Acre - - - -	3	0	0			
Second and Third Ditto, at 8 *s.* *per* Acre - -	4	0	0			
Manure, 30 *s.* *per* Acre	15	0	0			
				22	0	0
Two Harrowings, and Sowing, at 2 *s.* 6 *d.* *per* Acre - - - -	1	5	0			
Seed, three Buſhels *per* Acre, at 4 *s.* *per* Buſh.	6	0	0			
Weeding, at 2 *s.* *per* Acre	1	0	0			
Reaping, Binding, and Carrying, at 6 *s.* *per* Acre - - - - -	3	0	0	11	5	0
				33	5	0

	l.	s.	d.	l.	s.	d.
Brought over - - - - -				33	5	0
Second Year, for Barley, coſts 11 *l.* 6 *s.* 8 *d. viz.*						
Once Plowing, at 6 *s. per* Acre - - - -	3	0	0			
Harrowing and Sowing, at 1 *s.* 6 *d. per* Acre	0	15	0			
Seed, 4 Buſhels *per* Acre, at 2 *s. per* Buſhel - -	4	0	0			
Weeding, at 1 *s. per* Acre	0	10	0			
Cutting, Raking, and Carrying, at 3 *s.* 2 *d. per* Acre - - - -	1	11	8			
Graſs-Seeds, at 3 *s. per* Acre - - - -	1	10	0			
				11	6	8
				44	11	8
Third and Fourth Years, lying in Graſs, coſt nothing; So that the Expence of Ten Acres in Four Years comes to 44 *l.* 11 *s.* 8 *d.* and in Twenty Years to - -				222	18	4
Firſt Year's Produce is half a Load of Wheat *per* Acre, at 7 *l.* - -	35	0	0			
Second Year's Produce is Two Quarters of Barley *per* Acre, at 1 *l.* -	20	0	0			
Third and Fourth Years Graſs is valued at 1 *l.* 10 *s. per* Acre - -	15	0	0			
So that the Produce of Ten Acres in Four Years is - - - -	70	0	0			

And in Twenty Years it will be	350	0	0
Deduct the Expence, and there remains clear Profit on Ten Acres in 20 Years by the Old Way	127	1	8

II. *In the New Way.*

	l.	s.	d.			
Firſt Year's extraordinary Expence is, for plowing and manuring the Land, the ſame as in Old Way	- - - -			22	0	0
Plowing once more, at 4 *s. per* Acre	2	0	0			
Seed, 9 Gallons *per* Acre, at 4 *s. per* Buſhel	2	5	0			
Drilling, at 7 *d. per* Acre	0	5	10			
Hand-hoeing and Weeding, at 2*s.* 6*d. per* Acre	1	5	0			
Horſe-hoeing Six times, at 10 *s. per* Acre	5	0	0			
Reaping, Binding, and Carrying, at 6 *s. per* Acre	3	0	0			
The ſtanding annual Charge on Ten Acres is	13	15	10			
Therefore the Expence on Ten Acres in Twenty Years is				275	16	8
Add the Extraordinaries of the Firſt Year, and the Sum is				297	16	8
The yearly Produce is at leaſt Two Quarters of Wheat *per* Acre, at 1 *l.* 8 *s. per* Quarter; which, on Ten Acres in Twenty Years, amounts to				560	0	0
Therefore, all things paid, there remains clear Profit on Ten Acres in Twenty Years by the New Way				262	3	4

So that the Profit on Ten Acres of Land in Twenty Years, in the New Way, exceeds that in the Old by 135 *l.* 1 *s.* 8 *d.* and conſequently is conſiderably more than double thereof: an ample Encouragement to practiſe a Scheme, whereby ſo great Advantage will ariſe from ſo ſmall a Quantity of Land, in the Compaſs of a Twenty-one Years Leaſe; One Year being allowed, both in the Old and New Way, for preparing the Ground.

It ought withal to be obſerved, that Mr. *Tull*'s Huſbandry requires no Manure at all, tho' we have here, to prevent Objections, allowed the Charge thereof for the firſt Year; and moreover, that tho' the Crop of Wheat from the *Drill-plough* is here put only at Two Quarters on an Acre, yet Mr. *Tull* himſelf, by actual Experiment and Meaſure, found the Produce of his drilled Wheat-crop amounted to almoſt Four Quarters on an Acre: And, as he has delivered this Fact upon his own Knowlege, ſo there is no Reaſon to doubt of his Veracity, which has never yet been called in queſtion. But that we might not be ſuppoſed to have any Prejudice in favour of his Scheme, we have choſen to take the Calculations of others rather than his, having no other View in what we have ſaid, than to promote the Cauſe of Truth, and the public Welfare.

The Wheat and Turnep Drill-Boxes, or the Drill-Plough complete, mentioned in this Treatiſe, may be had at Mr. *Mulford*'s in *Curſitor-ſtreet, Chancery-lane, London.*

CHAP. I.

Of ROOTS and LEAVES.

SINCE the moſt immediate Uſe of *Agriculture*, in feeding Plants, relates to their *Roots*, they ought to be treated of in the firſt Place.

Roots are very different in different Plants: But 'tis not neceſſary here to take notice of all the nice Diſtinctions of them; therefore I ſhall only divide them in general into Two Sorts, *viz. Horizontal-Roots*, and *Tap-Roots*, which may include them all.

All have Branchings and Fibres going all manner of ways, ready to fill the Earth that is open.

But ſuch *Roots* as I call Horizontal (except of Trees) have ſeldom any of their Branchings deeper than the Surface or Staple of the Earth, that is commonly mov'd by the Plough or Spade.

The Tap-Root commonly runs down Single and Perpendicular (*a*), reaching ſometimes many Fathoms below.

This (tho' it goes never ſo deep) has horizontal ones paſſing out all round the Sides; and extend to ſeveral Yards Diſtance from it, after they are by their

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(*a*) In this manner deſcends the firſt Root of every Seed; but of Corn very little, if at all, deeper than the Earth is tilled.

Theſe firſt Seed-Roots of Corn die as ſoon as the other Roots come out near the Surface, above the Grain; and therefore this firſt is not called a Tap-Root; but yet ſome of the next Roots that come out near the Surface of the Ground, always reach down to the Bottom of the pulveriz'd Staple; as may be ſeen, if you carefully examine it in the Spring time; but this firſt Root in Saint-foin becomes a Tap-Root.

Minuteneſs, and earthy Tincture, become inviſible to the naked Eye.

A Method how to find the Diſtance to which Roots *extend Horizontally.*

Pl. 6. *Fig.* 7. Is a Piece or Plot dug and made fine in whole hard Ground, the End *A* 2 Feet, the End *B* 12 Feet, the Length of the Piece 20 Yards; the Figures in the middle of it are 20 *Turneps*, ſown early, and well ho'd.

The manner of this Hoing muſt be at firſt near the Plants, with a Spade, and each time afterwards, a Foot farther Diſtance, till all the Earth be once well dug; and if Weeds appear where it has been ſo dug, hoe them out ſhallow with the Hand-Hoe. But dig all the Piece next the out Lines deep every time, that it may be the finer for the *Roots* to enter, when they are permitted to come thither.

If theſe *Turneps* are all gradually bigger, as they ſtand nearer to the End *B*, 'tis a Proof they all extend to the Outſide of the Piece; and the *Turnep* 20 will appear to draw Nouriſhment from Six Feet Diſtance from its Centre.

But if the *Turneps* 16, 17, 18, 19, 20, acquire no greater Bulk than the *Turnep* 15, it will be clear, that their *Roots* extend no farther than thoſe of the *Turnep* 15 does; which is but about 4 Feet.

By this Method the Diſtance of the Extent of *Roots* of any Plant may be diſcover'd.

What put me upon this Method was an Obſervation of Two Lands (or Ridges) drill'd with *Turneps* in Rows, a Foot aſunder, and very even in them, the Ground, at both Ends, and one Side, was hard and unplow'd; the *Turneps*, not being ho'd, were very poor, ſmall, and yellow, except the Three outſide Rows, *B*, *C*, *D*, which ſtood next to the Land (or Ridge) *E*, which Land being plow'd and harrow'd, at the time the Land *A* ought to have been ho'd, gave a dark flouriſhing Colour to theſe three Rows; and the *Turneps* in the Row *D*, which ſtood fartheſt off from the new-plow'd Land *E*, received ſo much Benefit from it, as to grow twice as big as any of the more diſtant Rows. The Row *C*, being a Foot nearer to the new-plow'd Land, became twice as large as thoſe in *D*; but the Row *B*, which was next to the Land *E*, grew much larger yet *(a)*.

F Plate 6. is a Piece of hard whole Ground, of about two Perch in Length, and about 2 or 3 Feet broad, lying betwixt thoſe Two Lands, which had not been plow'd that Year; 'twas remarkable, that during the Length of this interjacent hard Ground, the Rows *B*, *C*, *D*, were as ſmall and yellow as any in the Land.

The *Turneps* in the Row *D*, about three Feet diſtant from the Land *E*, receiving a double Increaſe, proves they had as much Nouriſhment from the Land *E*, as from the Land *A*, wherein they ſtood; which Nouriſhment was brought by leſs than half the Number of *Roots* of each of theſe *Turneps*.

In their own Land they muſt have extended a Yard all round, elſe they could not have reach'd the Land *E*, wherein 'tis probable theſe few Roots went

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(a) A like Obſervation to this on the Land E, has been made in ſeveral Turnep-Fields of divers Farmers, where Lands adjoining to the Turneps have been well tilled; all the Turneps of the contiguous Lands that were within three or four Feet, or more, of the newly pulveriz'd Earth, received as great, or greater Increaſe, in the Manner as my Rows B C D did; and what is yet a greater Proof of the Length of Roots, and of the Benefit of deep Hoing, all theſe Turneps have been well Hand-ho'd; which is a good Reaſon why the Benefit of the deep Pulveration ſhould be perceivable at a greater Diſtance from it than mine, becauſe my Turneps, not being hoed at all, had not Strength to ſend out their Roots through ſo many Feet of unpulveriz'd Earth, as theſe can through their Earth pulveriz'd by the Hoe, tho' but ſhallowly.

This Obſervation, as 'tis related to me (I being unable to go far enough to ſee it myſelf), ſufficiently demonſtrates the mighty Difference there is between Hand-hoing and Horſe-hoing.

more than another Yard, to give each *Turnep* as much Increaſe as all the Roots had done in their own Land.

Except that it will hereafter appear, that the new Nouriſhment taken at the Extremities of the Roots in the Land *E*, might enable the Plants to ſend out more new Roots in their own Land, and receive ſomething more from thence.

The Row *C* being twice as big as the Row *D*, muſt be ſuppos'd to extend twice as far; and the Row *B*, four times as far, in proportion as it was of a Bulk quadruple to the Row *D*.

A *Turnep* has a Tap-Root, from whence all theſe Horizontal-Roots are deriv'd.

And 'tis obſervable; that betwixt theſe two Lands there was a Trench, or Furrow, of about the Depth of Nine or Ten Inches, where theſe Roots muſt deſcend firſt, and then aſcend into the Land *E*: But it muſt be noted, that ſome ſmall Quantity of Earth was, by the Harrowing, fall'n into this Furrow, elſe the Roots could not have paſs'd thro' it:

Roots will follow the open Mould (*a*), by deſcending

(*a*) A Chalk-Pit, contiguous to a Barn, the Area of which being about 40 Perch of Ground, was made clean and ſwept; ſo that there was not the Appearance of any Part of a Vegetable, more than in the Barn's Floor: Straw was thrown from thence into the Pit, for Cattle to lie on; the Dung made thereby was haled away about Three Years after the Pit had been cleanſed; when, at the Bottom of it, and upon the Top of the Chalk, the Pit was cover'd all over with Roots, which came from a Witch-Elm, not more than Five or Six Yards in Length, from Top to Bottom, and which was about Five Yards above, and Eleven Yards from the Area of the Pit; ſo that in Three Years the Roots of this Tree extended themſelves Eight times the Length of the Tree, beyond the Extremities of the old Roots, at Eleven Yards Diſtance from the Body: The annual-increaſed Length of the Roots was near Three times as much the Height of the Tree.

I'm told an Objection hath been made from hence againſt the Growth of a Plant's being in proportion to the Length of its Roots; but when the Caſe is fully ſtated, the Objection may vaniſh. This Witching perpendicularly, and mounting again in the ſame manner: As I have obſerv'd the Roots of a Hedge to do, that have paſs'd a ſteep Ditch two Feet deep, and reach'd the Mould on the other ſide, and there fill it; and digging Five Feet diſtant from the Ditch, found the Roots large, tho' this Mould was very ſhallow, and no Roots below the good Mould.

So in an Orchard, where the Trees are planted too deep, below the Staple or good Mould, the Roots, at a little Diſtance from the Stem, are all as near the upper Superficies of the Ground, as of thoſe Trees, which are planted higher than the Level of the Earth's Surface.

But the Damage of planting a Tree too low in moiſt Ground is, that in paſſing thro' this low Part, ſtanding in Water, the Sap is chill'd, and its Circulation thereby retarded.

One Cauſe of Peoples not ſuſpecting Roots to extend to the Twentieth Part of the Diſtance, which in reality they do, was from obſerving theſe Horizontal-Roots, near the Plant, to be pretty taper; and if they did diminiſh on, in proportion to what they do

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Witch-Elm is a very old decay'd Stump, which is here called a *Stagger*, appearing by its Crookedneſs to have been formerly a *Plaſher* in an old White-thorn Hedge wherein it ſtands: It had been lopped many Years before that accidental Increaſe of Roots happened; it was ſtunted, and ſent out poor Shoots; but in the third Year of theſe Roots, its Boughs being moſt of them horizontally inclined, were obſerved to grow vigourouſly, and the Leaves were broad, and of a flouriſhing Colour; at the End of the third Year all theſe Roots were taken away, and the *Area* being a Chalk-Rock lying uncovered, round the Place where the Single Root, that produced all theſe, came out of the Bank, no more Roots could run out on the bare Chalk, and the Growth of the Boughs has been but little ſince.

Wheat, drill'd in Double Rows in *November*, in a Field well till'd before Planting, look'd yellow, when about Eighteen Inches high; at Two Feet Diſtance from the Plants, the Earth was Ho-plow'd, which gave ſuch Nouriſhment to 'em, that they recover'd their Health, and changed their ſickly Yellow, to a lively green Colour.

there, they muſt ſoon come to an End. But the Truth is, that after a few Inches, they are not diſcernibly taper, but paſs on to their Ends very nearly of the ſame Bigneſs; this may be ſeen in *Roots* growing in Water, and in ſome other, tho' with much Care and Difficulty.

In pulling up the aforemention'd *Turneps*, their Roots ſeem'd to end at few Inches Diſtance from the Plants, they being farther off, too fine to be perceiv'd by ordinary Obſervation.

I found an extreme ſmall Fibre on the Side of a *Carrot*, much leſs than a Hair; but thro' a Microſcope it appear'd a large Root, not taper, but broken off ſhort at the End, which it is probable might have (before broken off) extended near as far as the *Turnep* Roots did. It had many Fibres going out of it, and I have ſeen that a *Carrot* will draw Nouriſhment from a great Diſtance, tho' the Roots are almoſt inviſible, where they come out of the *Carrot* itſelf.

By the Piece *F* Plate 6. may be ſeen, that thoſe Roots cannot penetrate, unleſs the Land be open'd by Tillage, *&c.*

As Animals of different Species have their Guts bearing different Proportions to the Length of their Bodies; ſo 'tis probable, different Species of Plants may have their Roots as different. But if thoſe which have ſhorter Roots have more in Number, and having ſet down the means how to know the Length of them in the Earth, I leave the different Lengths of different Species to be examin'd by thoſe who will take the Pains of more Trials. This is enough for me, that there is no Plant commonly propagated, but what will ſend out its Roots far enough, to have the Benefit of all the ho'd Spaces or Intervals I in the following Chapters allot them, even tho' they ſhould not have Roots ſo long as their Stalks or Stems.

And this great Length of Roots will appear very reaſonable, if we compare the Largeneſs of the Leaves (which are the Parts ordain'd for Excretion) with the Smalneſs of the Capillary Roots, which muſt make up in Length or Number what they want in Bigneſs, being deſtin'd to range far in the Earth, to find out a Supply of Matter to maintain the whole Plant; whereas the chief Office of the Stalks and Leaves is only to receive the ſame, and to diſcharge into the Atmoſphere ſuch Part thereof as is found unfit for Nutrition; a much eaſier Taſk than the other, and conſequently fewer Paſſages ſuffice, theſe ending in an obtuſe Form; for otherwiſe the Air would not be able to ſuſtain the Stalks and Leaves in their upright Poſture; but the Roots, tho' very weak and ſlender, are eaſily ſupported by the Earth, notwithſtanding their Length, Smalneſs, and Flexibility.

Plants have no Stomach, nor *Oeſophagus*, which are neceſſary to convey the Maſs of Food to an Animal: Which Maſs, being exhauſted by the Lacteals, is eliminated by way of Excrements; but the Earth itſelf being that Maſs to the Guts (or Roots) of Plants, they have only fine Recrements, which are thrown off by the Leaves.

In this, Animal and Vegetable Bodies agree, that Guts and Roots are both injured by the open Air; and Nature has taken an equal Care, that both may be ſupply'd with Nouriſhment, without being expos'd to it. Guts are ſupply'd from their Inſides, and Roots from their Outſides.

All the Nutriment (or *Pabulum*) which Guts receive for the Uſe of an Animal, is brought to them; but Roots muſt ſearch out and fetch themſelves all the *Pabulum* of a Plant; therefore a greater Quantity of Roots, in Length or Number, is neceſſary to a Plant, than of Guts to an Animal.

All *Roots* are as the Inteſtines of Animals, and have their Mouths or Lacteal Veſſels opening on their outer ſpongy Superficies, as the Guts of Animals have theirs opening in their inner ſpongy Superficies.

The Animal Lacteals take in their Food by the Preſſure that is made from the Periſtaltic Motion, and that Motion caus'd by the Action of Reſpiration, both which Motions preſs the Mouths of the Lacteals againſt the Maſs or Soil which is within the Guts, and bring them into cloſer Contact with it.

Both theſe Motions are ſupply'd in Roots by the Preſſure occaſion'd by the Increaſe of their Diameters in the Earth, which preſſes their Lacteal Mouths againſt the Soil without. But in ſuch Roots as live in Water, a Preſſure is conſtantly made againſt the Roots by the Weight and Fluidity of the Water; this preſſes ſuch fine Particles of Earth it contains, and which come into Contact with their Mouths, the cloſer to them.

And when *Roots* are in a till'd Soil, a great Preſſure is made againſt them by the Earth, which conſtantly ſubſides, and preſſes their Food cloſer and cloſer, even into their Mouths; until itſelf becomes ſo hard and cloſe, that the weak Sorts of Roots can penetrate no farther into it, unleſs re-open'd by new Tillage, which is call'd Hoing.

When a good Number of Single-Mint Stalks had ſtood in Water, until they were well ſtock'd with Roots from their Two lower Joints, and ſome of them from Three Joints, I ſet one in a Mint-Glaſs full of Salt-water; this Mint became perfectly dead within three Days.

Another Mint I put into a Glaſs of fair Water; but I immers'd one String of its Roots (being brought over the Top of that Glaſs) into another Glaſs of Salt-water, contiguous to the Top of the other Glaſs: This *Mint* dy'd alſo very ſoon.

Of another (ſtanding in a Glaſs of Water and Earth till it grew vigorouſly) I ty'd one ſingle Root into a Bag, which held a Spoonful of dry Salt, adjoining to the Top of the Glaſs, which kill'd this ſtrong Mint alſo. I found that this Salt was ſoon diſſolv'd, tho' on the Outſide of the Glaſs; and tho' no Water reach'd ſo high, as to be within Two Inches of the Joint which produc'd this Root: The Leaves of all theſe were ſalt as Brine to the Taſte.

Of another, I put an upper Root into a ſmall Glaſs of Ink, inſtead of a Bag of Salt, in the Manner above-mention'd; this Plant was alſo kill'd by ſome of the Ink Ingredients. The Blackneſs was not communicated to the Stalk, or Leaves, which inclin'd rather to a yellowiſh Colour as they died, which ſeem'd owing to the *Copperas*.

I made a very ſtrong Liquor with Water, and bruiſed Seeds of *Wild-Garlick*, and, filling a Glaſs therewith, plac'd the Top of it cloſe to the Top of another Glaſs, having in it a Mint, two or three of whoſe upper Roots, put into this ſtinking Liquor, full of the bruiſed Seeds, and there remaining, it kill'd the Mint in ſome time; but it was much longer in dying than the others were with Salt and Ink. It might be, becauſe theſe Roots in the *Garlick* were very ſmall, and did not bear ſo great a Proportion to their whole Syſtem of Roots, as the Roots, by which the other Mints were poiſon'd, did to theirs.

When the Edges of the Leaves began to change Colour, I chew'd many of them in my Mouth, and found at firſt the ſtrong aromatic Flavour of Mint, but that was ſoon over; and then the nauſeous Taſte of *Garlick* was very perceptible to my Palate.

I obſerv'd, that when the *Mint* had ſtood in a Glaſs of Water, until it ſeem'd to have finiſh'd its Growth, the Roots being about a Foot long, and of an earthy Colour, after putting in ſome fine Earth, which ſunk down to the Bottom, there came from the upper Joint a new Set of white Roots, taking their Courſe on the Outſide of the Heap of old Roots downwards, until they reach'd the Earth at the Bottom; and then, after ſome time, came to be of the ſame earthy Colour with the old ones.

Another *Mint* being well rooted from Two Joints, about Four Inches aſunder; I plac'd the Roots of the lower Joint in a deep Mint-Glaſs, having Water at the Bottom, and the Roots of the upper Joint into a ſquare Box, contriv'd for the Purpoſe, ſtanding over the Glaſs, and having a Bottom, that open'd in the Middle, with a Hole, that ſhut together cloſe to the Stalk, juſt below the upper Joint; then laying all theſe upper Roots to one Corner of the Box, I fill'd it with Sand, dry'd in a Fire-ſhovel, and found, that in one Night's time, the Roots of the lower Joint, which reach'd the Water at the Bottom of the Glaſs, had drawn it up, and imparted ſo much thereof to thoſe Roots in the Box above, that the Sand, at that Corner where they lay, was very wet, and the other three Corners dry. This Experiment I repeated very often, and it always ſucceeded as that did.

And for the ſame Purpoſe I prepar'd a ſmall Trough, about Two Foot long, and plac'd a Mint-Glaſs under each End of the Trough; over each Glaſs I plac'd a Mint, with half its Roots in the Glaſs, the other half in the Trough: The Mints ſtood juſt upon the Ends of the Trough. Then I cover'd theſe Roots with pulveriz'd Earth, and kept the Glaſſes ſupply'd with Water; and as oft as the white fibrous Roots ſhot thro' the Earth, I threw on more Earth, till the Trough would hold no more; and ſtill the white Fibres came thro', and appear'd above it; but all ſeem'd (as I ſaw by the Help of a coarſe Microſcope) to turn, and when they came above-ground, their Ends enter'd into it again. Theſe two *Mints* grew thrice as large as any other *Mint* I had, which were many, that ſtood in Water, and much larger than thoſe which ſtood in Water with Earth in it: They being all of an equal Bigneſs when ſet in, and ſet at the ſame time. Tho' theſe two, ſtanding in my Chamber, never had any Water in their Earth, but what thoſe Roots, which reach'd the Water in the Glaſſes, ſent up to the Roots, which grew in the Trough. The vaſt Quantity of Water theſe Roots ſent up, being ſufficient to keep all the Earth in the Troughs moiſt, tho' of a thouſand times greater Quantity than the Roots which water'd it, makes it probable, that the Water paſs'd out of the Roots into the Earth, without mixing at all with the Sap, or being alter'd to any Degree. The Earth kept always moiſt, and in the hot Weather there would not remain a Drop of Water in the Glaſſes, when they had not been freſh ſupply'd in two Days and one Night; and yet theſe Roots in the Glaſſes were not dry'd, tho' they ſtood ſometimes a whole Day and Night thus in the empty Glaſſes. Theſe two Mints have thus liv'd all one Summer.

Remarks on the Mints, *&c.*

Tho' the Veſſels of Marine Plants be ſome ways fortify'd againſt the Acrimony of Salt, as Sea-fiſh are; yet the Mints all ſhew, that Salt is Poiſon to other Plants.

The Reaſon why the Salts in Dung, Brine, or Urine, do not kill Plants in the Field, or Garden, is, that their Force is ſpent in acting upon, and dividing the Parts of Earth; neither do theſe Salts, or at leaſt any conſiderable Quantity of them, reach the Roots.

I try'd Salt to many Potatoes in the Ground, being undermin'd, and a few of their Roots put into a Diſh of Salt-water, they all died ſooner or later, according to their Bigneſs, and to the Proportions the Quantity of Salt apply'd did bear to them.

By the Mints it appears, that Roots make no Diſtinctions in the Liquor they imbibe, whether it be for their Nouriſhment or Deſtruction; and that they do not inſume what is diſagreeable, or Poiſon to them, for lack of other Suſtenance; ſince they were very vigorous, and well fed in the Glaſſes, at the time when the moſt inconſiderable Part of their Number had the Salt, Garlick, and Ink offer'd to them.

The ſixth *Mint* ſhews, that when new Earth is apply'd to the old Roots, a Plant ſends out new Roots on purpoſe to ſeed on it: And that the more Earth is given it, the more Roots will be form'd, by the new Vigour the Plant takes from the Addition of Earth. This correſponds with the Action of Hoing; for every time the Earth is mov'd about Roots, they have a Change of Earth, which is new to them.

The ſeventh *Mint* proves, that there is ſuch a Communication betwixt all the Roots, that when any of them have Water, they do impart a Share thereof to all the reſt: And that the Root of the lower Joint of this Mint had Paſſages (or Veſſels) leading from them, through the Stalk, to the Roots of the upper Joint; tho' the clear Stalk (through which it muſt have paſs'd) that was betwixt theſe two Joints, was ſeveral Inches in Length.

This accounts for the great Produce of long tap-rooted Plants, ſuch as *Luſern* and *St. Foin*, in very dry Weather: for the Earth at a great Depth is always moiſt. It accounts alſo for the good Crops we have in dry Summers, upon Land that has a Clay Bottom; for there the Water is retain'd a long time, and the lower Roots of Plants which reach it, do, like thoſe of this Mint, ſend up a Share to all the higher Roots.

If thoſe Roots of a Plant, which lie at the Surface of the Ground, did not receive Moiſture from other Roots, which lie deeper, they could be of no Uſe in dry Weather. But 'tis certain, that if this dry Surface be mov'd or dung'd, the Plant will be found to grow the faſter, tho' no Rain falls; which ſeems to prove, both that the deep Roots communicate to the ſhallow a Share of their Water, and receive in Return from them a Share of Food, in common with all the reſt of the Plant, as in the Mints they did.

The two laſt *Mints* ſhew, that when the upper Roots have Moiſture (as they had in the Earth in the Trough, carried thither firſt by the lower Roots) they impart ſome of it to the lower, elſe theſe could not have continu'd plump and freſh, as they did for 24 Hours in the empty Glaſs. And I have ſince obſerved them to do ſo, in the cooler Seaſon of the Year, for ſeveral Weeks together, without any other Water, than what the upper Roots convey'd to them, from the moiſt Earth above in the Trough *(a)*. I know not what Time theſe Roots might continue to be ſupply'd thus in the hot Weather, becauſe I did not try any longer, for fear of killing them.

But it muſt be noted, that the Depth of the Glaſs protected the Roots therein from the Injury of the Motion of the free Air, which would have have dry'd them, if they had been out of the Glaſs.

In this Trough is ſhewn moſt of the Hoing Effects; *viz.* That Roots, by being broken off near the Ends, increaſe their Number, and ſend out ſeveral where one is broken off.

That the Roots increaſe their Fibres every time the Earth is ſtirr'd about them.

That the ſtirring the Earth makes the Plants grow the faſter.

LEAVES are the Parts or Bowels of a Plant, which perform the ſame Office to Sap, as the Lungs of an Animal do to Blood; that is, they purify or cleanſe it of the Recrements, or fuliginous Steams, received in the Circulation, being the unfit Parts of the Food; and perhaps ſome decay'd Particles, which fly off the

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(a) 'Tis certain, that Roots and other Chyle-Veſſels of a Plant have a free Communication throughout all their Cavities, and the Liquor in them will run towards that Part where there is leaſt Reſiſtance; and ſuch is that which is the moſt empty, whether it be above or below; for there are no *Valves* that can hinder the Deſcent or Aſcent of Liquor in theſe Veſſels, as appears by the growing of a Plant in an inverted Poſture.

Veſſels, through which Blood and Sap do paſs reſpectively.

Beſides which Uſe, the Nitro-aereous Particles may there enter, to keep up the vital Ferment or Flame.

Mr. *Papin* ſhews, that Air will paſs in at the Leaves, and out thro' the Plant at the Roots, but Water will not paſs in at the Leaves; and that if the Leaves have no Air, a Plant will die; but if the Leaves have Air, tho' the Root remain in Water *in vacuo*, the Plant will live and grow.

Dr. *Grew*, in his Anatomy of Plants, mentions Veſſels, which he calls, Net-work, Cobweb, Skeins of Silk, *&c.* but above all, the Multitude of Air-Bladders in them, which I take to be of the ſame Uſe in Leaves, as the Veſiculæ are in Lungs. Leaves being as Lungs inverted, and of a broad and thin Form; their Veſiculæ are in Contact with the free open Air, and therefore have no need of Trachea, or Bronchia, nor of Reſpiration.

CHAP. II.

Of Food *of* Plants.

THE chief Art of an Huſbandman is to feed Plants to the beſt Advantage; but how ſhall he do that, unleſs he knows what is their Food? By Food is meant that Matter, which, being added and united to the firſt *Stamina* of Plants, or *Plantulæ*, which were made in little at the Creation, gives them, or rather is their Increaſe.

'Tis agreed, that all the following Materials contribute, in ſome manner, to the Increaſe of Plants; but 'tis diſputed which of them is that very Increaſe or Food. 1. *Nitre.* 2. *Water.* 3. *Air.* 4. *Fire.* 5. *Earth.*

I will not mention, as a Food, that acid Spirit of the Air, ſo much talk'd of; ſince by its eating aſunder Iron Bars it appears too much of the Nature of *Aqua Fortis*, to be a welcome Gueſt alone to the tender Veſſels of the Roots of Plants.

Nitre is uſeful to divide and prepare the Food, and may be ſaid to nouriſh Vegetables in much the ſame Manner as my Knife nouriſhes me, by cutting and dividing my Meat: But when *Nitre* is apply'd to the Root of a Plant, it will kill it as certainly as a Knife miſapply'd will kill a Man: Which proves, that *Nitre* is, in reſpect of Nouriſhment, juſt as much the Food of Plants, as *White Arſenick* is the Food of Rats. And the ſame may be ſaid of Salts.

Water, from *Van-Helmont*'s Experiment, was by ſome great Philoſophers thought to be it. But theſe were deceived, in not obſerving, that Water, has always in its Intervals a Charge of Earth, from which no Art can free it. This Hypotheſis having been fully confuted by Dr. *Woodward*, no-body has, that I know of, maintain'd it ſince: And to the Doctor's Arguments I ſhall add more in the Article of Air.

Air, Becauſe its Spring, *&c.* is as neceſſary to the Life of Vegetables, as the Vehicle of Water is; ſome modern Virtuoſi have affirm'd, from the ſame and worſe Arguments, than thoſe of the Water-Philoſophers, that Air is the Food of Plants. Mr. *Bradley* being the chief, if not only Author, who has publiſh'd this Phantaſy, which at preſent ſeems to get Ground; 'tis fit he ſhould be anſwer'd: And this will be eaſily done, if I can ſhew, that he has anſwer'd this his own Opinion, by ſome or all of his own Arguments.

His firſt is, that of *Helmont*, and is thus related in Mr. *Bradley*'s general Treatiſe of *Huſbandry and Gardening*, Vol. I. *p.* 36. ‘ Who dry'd Two hun-‘ dred Pounds of Earth, and planted a Willow of ‘ Five Pounds Weight in it, which he water'd with

‘ Rain, or diſtill’d Water; and to ſecure it from any ‘ other Earth getting in, he covered it with a perforated Tin Cover. Five Years after, weighing the ‘ Tree, with all the Leaves it had borne in that Time, ‘ he found it to weigh One hundred Sixty-nine ‘ Pounds Three Ounces; but the Earth was only diminiſh’d about Two Ounces in its Weight.’

On this Experiment Mr. *Bradley* grounds his Airy Hypotheſis. But let it be but examined fairly, and ſee what may be thence inferr’d.

The Tin Cover was to prevent any other Earth from getting in. This muſt alſo prevent any Earth from getting out, except what enter’d the Roots, and by them paſs’d into the Tree.

A Willow is a very thirſty Tree, and muſt have drank in Five Years time ſeveral Tuns of Water, which muſt neceſſarily carry in its Interſtices a great Quantity of Earth (probably many times more than the Tree’s (*a*) Weight, which could not get out, but by the Roots of the Willow.

Therefore the Two hundred Pounds of Earth not being increaſed, proves that ſo much Earth as was poured in with the Water, did enter the Tree.

Whether the Earth did enter to nouriſh the Tree, or whether only in order to paſs through it (by way of Vehicle to the Air), and leave the Air behind for the Augment of the Willow, may appear by examining the Matter of which the Tree did conſiſt.

If the Matter remaining after the Corruption or Putrefaction of the Tree be Earth, will it not be a Proof, that the Earth remained in it, to nouriſh and augment it? for it could not leave what it did not firſt take, nor be augmented by what paſs’d through it. According to *Ariſtotle*’s Doctrine, and Mr. *Bradley*’s

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(*a*) The Body of an Animal receives a much leſs Increaſe in Weight than its Perſpirations amount to, as *Sanctorius*’s *Static-Chair* demonſtrates.

too, in Vol. I. *pag.* 72. "Putrefaction reſolves it "again into Earth, its firſt Principle."

The Weight of the Tree, even when green, muſt conſiſt of Earth and Water. Air could be no Part of it, becauſe Air being of no greater ſpecific Gravity than the incumbent Atmoſphere, could not be of any Weight in it; therefore was no Part of the One hundred Sixty-nine Pounds Three Ounces.

Nature has directed Animals and Vegetables to ſeek what is moſt neceſſary to them. At the Time when the *Fœtus* has a Neceſſity of Reſpiration, 'tis brought forth into the open Air, and then the Lungs are filled with Air. As ſoon as a Calf, Lamb, *&c.* is able to ſtand, it applies to the Teat for Food, without any Teaching. In like manner Mr. *Bradley* remarks, in his Vol. I. *pag.* 10. 'That almoſt every Stem and 'every Root are formed in a bending Manner under 'Ground; and yet all theſe Stems become ſtrait and 'upright when they come above-ground, and meet 'the Air; and moſt Roots run as directly downwards, 'and ſhun the Air as much as poſſible.'

Can any thing more plainly ſhew the Intent of Nature, than this his Remark does? *viz.* That the Air is moſt neceſſary to the Tree above-ground, to purify the Sap by the Leaves, as the Blood of Animals is depurated by their Lungs: And that Roots ſeek the Earth for their Food, and ſhun the Air, which would dry up and deſtroy them.

No one Truth can poſſibly contradict or interfere with any other Truth; but one Error may contradict and interfere with another Error, *viz.*

Mr. *Bradley*, and all Authors, I think, are of Opinion, that Plants of different Natures are fed by a different Sort of Nouriſhment; from whence they aver, that a Crop of Wheat takes up all that is peculiar to that Grain; then a Crop of Barley all that is proper to it; next a Crop of Peaſe, and ſo on, till each has drawn off all thoſe Particles which are proper to it; and then no more of theſe Grains will grow in that Land, till by Fallow, Dung, and Influences of the Heavens, the Earth will be again repleniſh'd with new Nouriſhment, to ſupply the ſame Sorts of Corn over again. This, if true (as they all affirm it to be), would prove, that the Air is not the Food of Vegetables. For the Air being in itſelf ſo homogeneous as it is, could never afford ſuch different Matter as they imagine; neither is it probable, that the Air ſhould afford the Wheat Nouriſhment more one Year, than the enſuing Year; or that the ſame Year it ſhould nouriſh Barley in one Field, Wheat in another, Peaſe in a Third; but that if Barley were ſown in the Third, Wheat in the Firſt, Peaſe in the Second, all would fail: Therefore this Hypotheſis of Air for Food interferes with, and contradicts this Doctrine of Neceſſity of changing Sorts.

I ſuppoſe, by Air, they do not mean dry Particles of Earth, and the Effluvia which float in the Air: The Quantity of theſe is too ſmall to augment Vegetables to that Bulk they arrive at. By that way of ſpeaking they might more truly affirm this of Water, becauſe it muſt be like to carry a greater Quantity of Earth than Air doth, in proportion to the Difference of their different ſpecific Weight; Water, being about 800 times heavier than Air, is likely to have 800 times more of that terreſtrial Matter in it; and we ſee this is ſufficient to maintain ſome Sort of Vegetables, as Aquatics; but the Air, by its Charge of Effluvia, *&c.* is never able to maintain or nouriſh any Plant; for as to the Sedums, Aloes, and all others, that are ſuppos'd to grow ſuſpended in the Air, 'tis a mere Fallacy; they ſeem to grow, but do not; ſince they conſtantly grow lighter, and tho' their Veſſels may be ſomewhat diſtended by the Ferment of their own Juices, which they received in the Earth, yet, ſuſpended in Air, they continually diminiſh in Weight (which is the true Augment of a Plant) until they grow to nothing,

nothing. So that this Inſtance of Sedums, *&c.* which they pretend to bring for Proof of this their Hypotheſis, is alone a full Confutation of it.

Yet if granted, that Air could nouriſh ſome Vegetables by the earthy Effluvia, *&c.* which it carry'd with it *(a)*, even that would be againſt them, not for them.

They might as well believe, that *Martins* and *Swallows* are nouriſh'd by the Air, becauſe they live on Flies and Gnats, which they catch therein; this being the ſame Food, which is found in the Stomach of the Chameleon.

If, as they ſay, the Earth is of little other Uſe to Plants, but to keep them fix'd and ſteady, there would be little or no Difference in the Value of rich and poor Land, dung'd or undung'd; for one would ſerve to keep Plants fix'd and ſteady, very near, if not quite, as well as the other.

If Water or Air was the Food of Plants, I cannot ſee what Neceſſity there ſhould be of Dung or Tillage.

4. *Fire.* No Plant can live without Heat, tho' different Degrees of it be neceſſary to different Sorts of Plants. Some are almoſt able to keep Company with the *Salamander*, and do live in the hotteſt Expoſures of the hot Countries. Others have their Abode with Fiſhes under Water, in cold Climates: for the Sun has his Influence, tho' weaker, upon the Earth cover'd with Water, at a conſiderable Depth; which appears by the Effect the Viciſſitudes of Winter and Summer have upon ſubterraqueous Vegetables.

Tho' every Heat is ſaid to be a different Degree of Fire; yet we may diſtinguiſh the Degrees by their different Effects. Heat warms; but Fire burns: The firſt helps to cheriſh, the latter deſtroys Plants.

(a) This is meant of dry Earth, by its Lightneſs (when pulveriz'd extremely fine) carried in the Air without Vapour: For the Atmoſphere, conſiſting of all the Elements, has Earth in it in conſiderable Quantity, mix'd with Water; but a very little Earth is ſo minutely divided, as to fly therein pure from Water, which is its Vehicle there for the moſt part.

5. *Earth.* That which nouriſhes and augments a Plant, is the true Food of it.

Every Plant is Earth, and the Growth and true Increaſe of a Plant is the Addition of more Earth.

Nitre (or other Salts) prepares the Earth, Water and Air move it, by conveying and fermenting it in the Juices; and this Motion is called Heat.

When this additional Earth is aſſimilated to the Plant, it becomes an abſolute Part of it.

Suppoſe Water, Air, and Heat, could be taken away, would it not remain to be a Plant, tho' a dead one?

But ſuppoſe the Earth of it taken away, what would then become of the Plant? Mr. *Bradley* might look long enough after it, before he found it in the Air amongſt his ſpecific or certain Qualities.

Beſides, too much *Nitre* (or other Salts) corrodes a Plant; too much Water drowns it; too much Air dries the Roots of it; too much Heat (or Fire) burns it; but too much Earth a Plant never can have, unleſs it be therein wholly buried; and in that Caſe it would be equally miſapply'd to the Body, as Air or Nitre would be to the Roots.

Too much Earth, or too fine, can never poſſibly be given to Roots; for they never receive ſo much of it, as to ſurfeit the Plant, unleſs it be depriv'd of Leaves, which, as Lungs, ſhould purify it.

And Earth is ſo ſurely the Food of all Plants, that with the proper Share of the other Elements, which each Species of Plants requires, I do not find but that any common Earth will nouriſh any Plant.

The only Difference of Soil (*a*) (except the Richneſs) ſeems to be the different Heat and Moiſture it has;

(*a*) As I have ſaid in my *Eſſay*, That *a Soil being once proper to a Species of Vegetables, it will always to continue to be ſo*; it muſt be ſuppoſed, that there be no Alteration of the *Heat* and *Moiſture* of it; and that this Difference I mean, is of its Quality of has; for if thoſe be rightly adjuſted, any Soil will nouriſh any Sort of Plant; for let *Thyme* and *Ruſhes* change Places, and both will die; but let them change their Soil, by removing the Earth wherein the *Thyme* grew, from the dry Hill down into the watry Bottom, and plant *Ruſhes* therein; and carry the moiſt Earth, wherein the *Ruſhes* grew, up to the Hill; and there *Thyme* will grow in the Earth that was taken from the *Ruſhes*; and ſo will the *Ruſhes* grow in the Earth that was taken from the *Thyme*; ſo that 'tis only more or leſs Water that makes the ſame Earth fit either for the Growth of *Thyme* or *Ruſhes*.

So for Heat; our Earth, when it has in the Stove the juſt Degree of Heat that each Sort of Plants requires, will maintain Plants brought from both the *Indies*.

Plants differ as much from one another in the Degrees of Heat and Moiſture they require, as a Fiſh differs from a Salamander.

Indeed *Miſletoe*, and ſome other Plants, will not live upon Earth, until it be firſt alter'd by the Veſſels of another Plant or Tree, upon which they grow, and therein are as nice in Food as an Animal.

There is no need to have recourſe to Tranſmutation; for whether Air or Water, or both, are tranſform'd into Earth or not, the Thing is the ſame, if it be Earth when the Roots take it; and we are convinced that neither Air nor Water alone, as ſuch, will maintain Plants.

Theſe kind of Metamorphoſes may properly enough be conſider'd in Diſſertations purely concerning Matter, and to diſcover what the component Particles of Earth are; but not at all neceſſary to be known, in relation to the maintaining of Vegetables.

of nouriſhing different Species of Vegetables, not of the Quantity of it; which Quantity may be alter'd by Diminution or Superinduction.

CHAP. III.

Of Paſture of Plants.

CATTLE feed on Vegetables that grow upon the Earth's external Surface; but Vegetables themſelves firſt receive, from within the Earth, the Nouriſhment they give to Animals.

The Paſture of Cattle has been known and underſtood in all Ages of the World, it being liable to Inſpection; but the Paſture of Plants, being out of the Obſervation of the Senſes, is only to be known by Diſquiſitions of Reaſon; and has (for ought I can find) paſt undiſcover'd by the Writers of Huſbandry *(a)*.

The Ignorance of this ſeems to be one principal Cauſe, that Agriculture, the moſt neceſſary of all Arts, has been treated of by Authors more ſuperficially than any other Art whatever. The Food or *Pabulum* of Plants, being prov'd to be Earth, where and whence *(b)* they take that, may properly be called their Paſture.

This Paſture I ſhall endeavour to deſcribe.

(a) When Writers of Huſbandry, in diſcourſing of Earth and Vegetation, come neareſt to the Thing, that is, the *Paſture of Plants*, they are loſt in the Shadow of it, and wander in a Wilderneſs of obſcure Expreſſions, ſuch as *Magnetiſm*, *Virtue*, *Power*, *Specific Quality*, *Certain Quality*, and the like; wherein there is no manner of Light for diſcovering the real Subſtance, but we are left by them more in the Dark to find it, than Roots are when they feed on it: And when a Man, no leſs ſagacious than Mr. *Evelyn*, has trac'd it thro' all the *Mazes* of the *Occult Qualities*, and even up to the *Metaphyſics*, he declares he cannot determine, whether the Thing he purſues be *Corporeal* or *Spiritual*.

(b) By the *Paſture* is not meant the *Pabulum* itſelf; but the *Superficies* from whence the *Pabulum* is taken by Roots.

'Tis the inner (or internal) Superficies *(a)* of the Earth; or, which is the ſame thing, 'tis the Superficies of the Pores, Cavities, or Interſtices of the divided Parts of the Earth, which are of two Sorts, viz. *Natural* and *Artificial*.

By Nature, the whole Earth (or Soil) is compoſed of Parts; and, if theſe had been in every Place abſolutely joined, it would have been without Interſtices or Pores, and would have had no internal Superficies, or Paſture for Plants; but ſince it is not ſo ſtrictly denſe *(b)*, there muſt be Interſtices at all thoſe Places where the Parts remain ſeparate and divided.

Theſe Interſtices, by their Number and Largeneſs, determine the ſpecific Gravity (or true Quantity) of every Soil: The larger they are, the lighter is the Soil; and the inner Superficies is commonly the leſs.

The Mouths, or Lacteals, being ſituate, and opening, in the convex Superficies of Roots, they take their *Pabulum*, being fine Particles of Earth, from the Superficies of the Pores, or Cavities, wherein the Roots are included.

(*a*) This Paſture of Plants never having been mentioned or deſcribed by any Author that I know of, I am at a loſs to find any other Term to deſcribe it by, that may be ſynonymous, or equipollent to it: Therefore, for want of a better, I call it the inner, or internal Superficies of the Earth. to diſtinguiſh it from the outer or external Superficies, or Surface, whereon we tread.

Inner or internal Superficies may be thought an abſurd Expreſſion, the Ajective expreſſing ſomething within, and the Subſtantive ſeeming to expreſs only what is without it; and indeed the Senſe of the Expreſſion is ſo; for the Vegetable Paſture is within the Earth, but without (or on the Outſides of) the divided Parts of the Earth.

And, beſides Superficies, muſt be joined with the Adjective Inner (or Internal) when 'tis uſed to deſcribe the Inſide of a thing that is hollow, as the Pores and Interſtices of the Earth are.

The Superficies, which is the Paſture of Plants, is not a bare Mathematical Superficies; for that is only imaginary.

(*b*) For were the Soil as denſe as Glaſs, the Roots or Vegetables (ſuch as our Earth produces) would never be able to enter its Pores.

And 'tis certain, that the Earth is not diveſted or robb'd of this *Pabulum*, by any other means, than by actual Fire, or the Roots of Plants.

For, when no Vegetables are ſuffer'd to grow in a Soil, it will always grow richer. Plow it, harrow it, as often as you pleaſe, expoſe it to the Sun in Horſe-Paths all the Summer, and to the Froſt of the Winter; let it be cover'd by Water at the Bottom of Ponds, or Ditches; or if you grind dry Earth to Powder, the longer 'tis kept expoſed, or treated by theſe or any other Method poſſible (except actual Burning by Fire); inſtead of loſing, it will gain the more Fertility.

Theſe Particles, which are the *Pabulum* of Plants, are ſo very minute *(a)* and light, as not to be ſingly attracted to the Earth, if ſeparated from thoſe Parts to which they adhere *(b)*, or with which they are in Contact (like Duſt to a Looking-Glaſs, turn it upwards, or downwards, it will remain affixt to it), as theſe Particles do to thoſe Parts, until from thence remov'd by ſome Agent.

(*a*) As to the Fineneſs of the *Pabulum* of Plants, 'tis not unlikely, that Roots may inſume no groſſer Particles, than thoſe on which the Colours of Bodies depend; but to diſcover the greateſt of thoſe Corpuſcles, Sir *Iſaac Newton* thinks will require a Microſcope, that with ſufficient Diſtinctneſs can repreſent Objects Five or Six hundred times bigger, than at a Foot Diſtance they appear to the naked Eye.

My Microſcope indeed is but a very ordinary one, and when I view with it the Liquor newly imbibed by a fibrous Root of a Mint, it ſeems more limpid than the cleareſt common Water, nothing at all appearing in it.

(*b*) Either Roots muſt inſume the Earth, that is their *Pabulum*, as they find it in whole Pieces, having intire Superficies of their own, or elſe ſuch Particles as have not intire Superficies of their own, but want ſome Part of it, which adheres to, or is Part of the Superficies of larger Particles, before they are ſeparated by Roots. The former they cannot inſume (unleſs contained in Water); becauſe they would fly away at the firſt Pores that were open: *Ergo* they muſt inſume the latter.

A Plant cannot ſeparate theſe Particles from the Parts to which they adhere, without the Aſſiſtance of Water, which helps to looſen them.

And 'tis alſo probable, that the Nitre of the Air may be neceſſary to relax this Superficies, to render the prolific Particles capable of being thence disjoin'd; and this Action of the Nitre ſeems to be what is call'd, Impregnating the Earth.

Since the groſſer Vegetable Particles, when they have paſs'd thro' a Plant, together with their moiſt Vehicle, do fly up into the Air inviſibly; 'tis not likely they ſhould, in the Earth, fall off from the Superficies of the Pores, by their own Gravity: And if they did fall off, they might fly away as eaſily before they enter'd Plants, as they do after they have paſs'd thro' them; and then a Soil might become the poorer (*a*) for all the Culture and Stirring we beſtow upon it; tho' no Plants were in it; contrary to Experience.

It muſt be own'd, that Water does ever carry, in its Interſtices, Particles of Earth fine enough to enter Roots; becauſe I have ſeen, that a great Quantity of Earth (in my Experiments) will paſs out of Roots ſet in Rain-water; and 'tis found that Water can never be, by any Art, wholly freed from its earthy Charge; therefore it muſt have carry'd in ſome Particles of Earth along with it: But yet I cannot hence conclude, that the Water did firſt take theſe fine Particles from the aforeſaid Superficies: I rather think, that they are exhal'd, together with very ſmall Pieces to which they adhere, and in the Vapour divided by the Aereal Nitre; and, when the Vapour is condens'd, they deſcend with it to repleniſh the

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(*a*) But we ſee it is always the richer by being frequently turned and expoſed to the Atmoſphere: Therefore Plants muſt take all their *Pabulum* from a Superficies of Parts of Earth; except what may perhaps be contained in Water fine enough to enter Roots intire with the Water.

the Paſture of Plants; and that theſe do not enter intire into Roots, neither does any other of the earthy Charge that any Water contains; except ſuch fine Particles which have already paſs'd thro' the Vegetable Veſſels, and been thence exhal'd.

This Conjecture is the more probable, for that Rain-water is as nouriſhing to Plants ſet therein, as Spring-water, tho' the latter have more Earth in it; and tho' Spring-water have ſome Particles in it, that will enter intire into Roots, yet we muſt conſider, that even that Water may have been many times exhal'd into the Air, and may have ſtill retain'd a great quantity of Vegetable Particles, which it received from Vegetable Exhalations in the Atmoſphere; tho' not ſo great a Quantity, as Rain-water, that comes immediately thence.

Theſe, I have to do with, are the Particles which Plants have from the Earth, or Soil; but they have alſo fine Particles of Earth from Water, which may impart ſome of its fineſt Charge to the Superficies of Roots, as well as to the Superficies of the Parts of the Earth (*a*), which makes the Paſture of Plants.

Yet it ſeems, that much of the Earth, contain'd in the cleareſt Water, is there in too large Parts to enter a Root; ſince we ſee, that in a ſhort time the Root's Superficies will, in the pureſt Water, be cover'd with Earth, which is then form'd into a terrene Paſture, which may nouriſh Roots; but very few Plants will live long in ſo thin a Paſture, as any Water affords them. I cannot find one as yet, that has liv'd a Year, without ſome Earth have been added to it.

And all Aquatics, that I know, have their Roots in the Earth, tho' cover'd with Water.

The Pores, Cavities, or Interſtices of the Earth, being of two Sorts, viz. *Natural* and *Artificial*; the

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(*a*) If Water does ſeparate, and take any of the mere *Pabulum* of Plants from the Soil, it gives much more to it.

one affords the Natural, the other the Artificial Paſture of Plants.

The natural Paſture alone will ſuffice, to furniſh a Country with Vegetables, for the Maintenance of a few Inhabitants; but if Agriculture were taken out of the World, 'tis much to be fear'd, that thoſe of all populous Countries, eſpecially towards the Confines of the frigid Zones (for there the Trees often fail of producing Fruit), would be oblig'd to turn *Anthropophagi*, as in many uncultivated Regions they do, very probably for that Reaſon.

The artificial Paſture of Plants is that inner Superficies, which is made from dividing the Soil by Art.

This does, on all Parts of the Globe, where uſed, maintain many more People than the natural Paſture (*a*); and in the colder Climates, I believe, it will not be

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(*a*) The extraordinary Increaſe of St. Foin, Clover, and natural Graſs, when their Roots reach into pulveriz'd Earth, exceeding the Increaſe of all thoſe other Plants of the ſame Species (that ſtand out of the Reach of it) above One hundred times, ſhew how vaſtly the Artificial Paſture of Plants exceeds the Natural. A full Proof of this Difference, (beſides very many I have had before) was ſeen by two Intervals in the middle of a poor Field of worn out St. Foin, pulveriz'd in the precedent Summer, in the manner deſcrib'd in a Note on the latter Part of Chap. XII. relating to St. *Foin*. Here not only the St. *Foin* adjoining to theſe Intervals recover'd its Strength, bloſſom'd, and ſeeded well, but alſo the natural Graſs amongſt it was as ſtrong, and had as flouriſhing a Colour, as if a Dung-heap had been laid in the Intervals; alſo many other Weeds came out from the Edges of the unplow'd Ground, which muſt have lain dormant a great many Years, grew higher and larger than ever were ſeen before in that Field; but, above all, there was a Weed amongſt the St. Foin, which generally accompanies it, bearing a white Flower; ſome call it *White Weed*, others *Lady's Bedſtraw*: Some Plants of this that ſtood near the Intervals, were, in the Opinion of all that ſaw them, increaſed to a Thouſand times the Bulk of thoſe of the ſame Species, that ſtood in the Field Three Feet diſtant from ſuch pulveriz'd Earth.

Note, Theſe Intervals were each an Hundred Perch long, and had each in them a treble Row of Barley very good. The Reaſon I take to be this, That the Land had lain ſtill ſeveral Years after be extravagant to ſay, Ten times as many: Or that, in caſe Agriculture were a little improved (as I hope to ſhew is not difficult to be done), it might maintain twice as many more yet, or the ſame Number, better.

The natural Paſture is not only leſs than the artificial, in an equal Quantity of Earth; but alſo, that little conſiſting in the Superficies of Pores, or Cavities, not having a free Communication *(a)* with one another, being leſs pervious to the Roots of all Vegetables, and requiring a greater Force to break thro' their Partitions; by that means, Roots, eſpecially of weak Plants, are excluded from many of thoſe Cavities, and ſo loſe the Benefit of them.

But the artificial Paſture conſiſts in Superficies of Cavities, that are pervious to all manner of Roots, and that afford them free Paſſage and Entertainment in and thro' all their Receſſes. Roots may here extend to the utmoſt, without meeting with any Barricadoes in their Way.

The internal Superficies, which is the natural Paſture of Plants, is like the external Superficies or

after its artificial Paſture was loſt; whereby all the Plants in it having only the natural Paſture to ſubſiſt on, became ſo extremely *ſmall* and *weak*, that they were not able to exhauſt the Land of ſo great a Quantity of the (vegetable) nouriſhing Particles as the Atmoſphere brought down to it.

And when by Pulveration the artificial Paſture came to be added to this Natural Paſture (not much exhauſted), and nothing at all ſuffered to grow out of it for above Three Quarters of a Year, it became rich enough, without any Manure, to produce this extraordinary Effect upon the Vegetables, whoſe Roots reached into it. How long this Effect may continue, is uncertain; but I may venture to ſay, it will continue until the Exhauſtion by Vegetables doth over-balance the Deſcent of the Atmoſphere, and the Pulveration.

And what I have ſaid of any one Species of Plants in this reſpect may be generally apply'd to the reſt.

(*a*) None of the natural Vegetable Paſture is loſt or injured by the artificial; but, on the contrary, 'tis mended by being mix'd with it, and by having a greater Communication betwixt Pore and Pore.

Surface of the Earth, whereon is the Paſture of Cattle; in that it cannot be inlarg'd without Addition of more Surface taken from Land adjoining to it, by inlarging its Bounds or Limits.

But the artificial Paſture of Plants may be inlarg'd, without any Addition of more Land, or inlarging of Bounds, and this by Diviſion only of the ſame Earth.

And this artificial Paſture may be increas'd in proportion to the Diviſion of the Parts of Earth, whereof it is the Superficies, which Diviſion may be mathematically infinite; for an Atom is nothing; neither is there a more plain Impoſſibility in Nature, than to reduce Matter to nothing, by Diviſion or Separation of its Parts.

A Cube of Earth of One Foot has but Six Feet of Superficies. Divide this Cube into Cubical Inches, and then its Superficies will be increas'd Twelve times, *viz.* to Seventy-two Superficial Feet. Divide theſe again in like Manner and Proportion; that is, Divide them into Parts that bear the ſame Proportion to the Inches, as the Inches do to the Feet; and then the ſame Earth, which had at firſt no more than Six Superficial Feet, will have Eight hundred Sixty-four Superficial Feet of artificial Paſture; and ſo is the Soil diviſible, and this Paſture increaſable *ad Infinitum.*

The common Methods of dividing the Soil are theſe; *viz.* by *Dung*, by *Tillage*, or by both (*a*).

CHAP. IV.

Of DUNG.

ALL ſorts of Dung and Compoſt contain ſome Matter, which, when mixt with the Soil, ferments therein; and by ſuch Ferment diſſolves, crum-

(*a*) For *Vis Unita Fortior.*

bles, and divides the Earth very much: This is the chief, and almoſt only Uſe of Dung: For, as to the pure earthy Part of it, the Quantity is ſo very ſmall, that, after a perfect Putrefaction, it appears to bear a moſt inconſiderable Proportion to the Soil it is deſign'd to manure; and therefore, in that reſpect, is next to nothing.

Its fermenting Quality is chiefly owing to the Salts wherewith it abounds; but a very little of this Salt applied alone to a few Roots of almoſt any Plant, will (as, in my Mint Experiments, it is evident common Salt does) kill it.

This proves, that its Uſe is not to nouriſh, but to diſſolve; *i. e.* Divide the terreſtrial Matter, which affords Nutriment to the Mouths of Vegetable Roots.

It is, I ſuppoſe, upon the account of the acrimonious fiery Nature of theſe Salts, that the Floriſts have baniſh'd Dung from their Flower-gardens.

And there is, I'm ſure, much more Reaſon to prohibit the Uſe of Dung in the Kitchen-Garden, on account of the ill Taſte it gives to eſculent Roots and Plants, eſpecially ſuch Dung as is made in great Towns.

'Tis a wonder how delicate Palates can diſpenſe with eating their own and their Beaſts Ordure, but a little more putrefied and evaporated; together with all ſorts of Filth and Naſtineſs, a Tincture of which thoſe Roots muſt unavoidably receive, that grow amongſt it.

Indeed I do not admire, that learned Palates, accuſtom'd to the *Goût* of *Silphium*, *Garlick*, *la Chair venee*, and mortify'd Veniſon, equalling the Stench and Rankneſs of this ſort of City-Muck, ſhould reliſh and approve of Plants that are fed and fatted by its immediate Contact.

People who are ſo vulgarly nice, as to nauſeate theſe modiſh Dainties, and whoſe ſqueamiſh Stomachs even abhor to receive the Food of Nobles, ſo little different from that wherewith they regale their richeſt Gardens, ſay that even the very Water, wherein a rich Garden-cabbage is boil'd, ſtinks; but that the Water, wherein a Cabbage from a poor undung'd Field is boil'd, has no manner of unpleaſant Savour; and that a Carrot, bred in a Dunghil, has none of that ſweet Reliſh, which a Field-Carrot affords.

There is a like Difference in all Roots, nouriſh'd with ſuch different Diet.

Dung not only ſpoils the fine Flavour of theſe our Eatables, but inquinates good Liquor. The dung'd Vineyards in *Languedoc* produce nauſeous Wine; from whence there is a Proverb in that Country, That poor Peoples Wine is beſt, becauſe they carry no Dung to their Vineyards.

Dung is obſerv'd to give great Encouragement to the Production of Worms; and Carrots in the Garden are much worm-eaten, when thoſe in the Field are free from Worms.

Dung is the Putrefaction of Earth, after it has been alter'd by Vegetable or Animal Veſſels. But if Dung be thoroughly ventilated and putrefy'd before it be ſpread on the Field (as I think all the Authors I have read direct) ſo much of its Salts will be ſpent in fermenting the Dung itſelf, that little of them will remain to ferment the Soil; and the Farmer who might dung One Acre in Twenty, by laying on his Dung whilſt fully replete with vigorous Salts, may (if he follows theſe Writers Advice to a Nicety) be forced to content himſelf with dunging one Acre in an Hundred.

This indeed is good Advice for Gardeners, for makeing their Stuff more palatable and wholſome; but would ruin the Farmer who could have no more Dung than what he could make upon his Arable Farm.

For every Sort of Dung, the longer time it ferments without the Ground, the leſſer time it has to ferment in it, and the weaker its Ferment will be.

The Reaſon given for this great Diminution of Dung is, that the Seeds of Weeds may be rotted, and loſe their vegetating Faculty; but this I am certain of by Demonſtration, that let a Dunghil remain Three Years unmov'd, though its Bulk be vaſtly diminiſh'd in that Time, and its beſt Quality loſt, Charlock-ſeed will remain ſound in it, and ſtock the Land whereon it is laid: For that Ferment which is ſufficient to conſume the Virtue of the ſtercoreous Salts, is not ſufficient to deſtroy the vegetative Virtue of Charlock-ſeeds, nor (I believe) of many other Sorts of Weeds.

The very Effluvia of animal Bodies, ſent off by Perſpiration, are ſo noxious as to kill the Animal that emits them, if confin'd to receive them back in great Quantity, by breathing in an Air replete with them; which appears from the ſoon dying of an Animal ſhut up in a Receiver full of Air. Yet this ſeems to be the moſt harmleſs of all ſorts of animal Excrements the Air can be infected with. How noxious then muſt be the more fetid Steams of Ordure!

If a Catalogue were publiſh'd of all Inſtances from Charnel-houſes (or Cœmeteries), and of the peſtiferous Effects, which have happen'd from the Putrefaction of dead Bodies, after great Battles, even in the open Air, no-body, I believe, would have a good Opinion of the Wholſomeneſs of Animal Dung; for if a great Quantity do ſo infect the Air, 'tis likely a leſs may infect it in proportion to that leſs Quantity.

In great Cities the Air is full of theſe Effluvia, which in hot Climes often produce the Peſtilence; and in cold Climes People are generally obſerv'd to live a leſs time, and leſs healthfully, in Cities, than in the Country; to which Difference, 'tis likely, that the eating unwholſome Gardenage may contribute.

This Dung is a fitter Food for venomous Creatures *(a)* than for edible Plants; and 'tis (no doubt) upon account of this, that dung'd Gardens are ſo much frequented by Toads, which are ſeldom or never ſeen in the open undung'd Fields.

What can we ſay then to the Salubrity of thoſe Roots themſelves, bred up and fatten'd among theſe Toads and Corruption? The Leaves indeed are only diſcharging ſome of the Filth, when we eat them; but the Roots have that unſavoury infected Food in their very Mouths, when we take them for our Nouriſhment.

But tho' *Dung* be, upon theſe and other accounts, injurious to the Garden, yet a conſiderable Quantity of it is ſo neceſſary to moſt Corn-fields, that without it little Good can be done by the old Huſbandry.

Dung is not injurious to the Fields *(b)*, being there in leſs Proportion: And the Produce of Corn is the Grain. When the Leaves have done their utmoſt to purify the Sap, the moſt refin'd Part is ſecern'd to be yet further elaborated by peculiar Organs; then, by the Veſſels of the Bloſſoms, 'tis become double-refin'd, for the Nouriſhment of the Grain; which is therefore more pure from Dung, and more wholſome, than any other Part of the Plant that bears it.

And common Tillage alone is not ſufficient for many Sorts of Corn, eſpecially Wheat, which is the King of Grains.

Very few Fields can have the Conveniency of a ſufficient Supply of Dung, to enable them to produce half the Wheat; thoſe will do near Cities, where they have Plenty of it.

(a) Mr. *Evelyn* ſays, that Dung is the Nurſe of Vermin.

(b) Such Plants as *Cabbages*, *Turneps*, *Carrots*, and *Potatoes*, when they are deſigned only for fatting of Cattle, will not be injured by Dung, Tillage, and Hoeing all together, which will make the Crops the greater, and the Cattle will like them never the worſe.

The Crop of 20 Acres will ſcarce make Dung ſufficient for one Acre, in the common Way of laying it on.

The Action of the Dung's Ferment affords a Warmth *(a)* to the Infant-plants, in their moſt tender State, and the moſt rigorous Seaſon.

But 'tis hard to know how long the Warmth of this Ferment laſteth, by reaſon of the great Difficulty to diſtinguiſh the very leaſt Degree of Heat from the very leaſt Degree of Cold.

Under the Name of Dung we may alſo underſtand whatever ferments with the Earth (except Fire); ſuch as green Vegetables cover'd in the Ground, *&c.*

As to the Difference of the Quantity of artificial Paſture made by *Dung* without Tillage, and that made by Tillage without *Dung*; the latter is many times greater, of which I had the following Proof. An unplow'd Land, wherein a Dunghil had lain for Two or Three Years, and being taken away, was planted with *Turneps*; at the ſame a till'd Land, contiguous thereto, was drill'd with *Turneps*, and Horſe-ho'd; the other, being Hand-ho'd, proſpered beſt at the firſt; but at laſt did not amount to the Fifth Part of the Till'd and Horſe-ho'd, in Bigneſs, nor in Crop. The Benefit of the Dung and Hand-hoe was ſo inconſiderable, in compariſon of the Plough and Hoe-plough; the little Quantity of artificial Paſture raiſed to the other, was only near the Surface, and did not reach deep enough to maintain the *Turneps*, till they arrived at the Fifth Part of the Growth of

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(a) But though Dung in fermenting may have a little Warmth, yet it may ſometimes, by letting more Water enter its Hollowneſs, be in a Froſt much colder than undung'd pulveriz'd Earth; for I have ſeen Wheat-plants in the Winter die in the very Spits of Dung, when undung'd drill'd Wheat adjoining to it, planted at the ſame time, has flouriſh'd all the ſame Winter; and I could not find any other Reaſon for this, but the Hollowneſs of the Dung; and yet it ſeemed to be well rotted.

thoſe, whoſe artificial Paſture reach'd to the Bottom of the Staple of the Land.

A like Proof is; That ſeveral Lands of *Turneps*, drill'd on the Level, at Three Foot Rows, plow'd, and doubly dung'd, and alſo Horſe-ho'd, did not produce near ſo good a Crop of *Turneps*, as Six Foot Ridges adjoining, Horſe-ho'd, tho' no Dung had been laid thereon for many Years: There was no other Difference, than that the Three Foot Rows did not admit the Hoe-plough to raiſe half the artificial Paſture, as the Six Foot Rows did. The Dung plow'd into the narrow Intervals, before drilling, could operate no further, with any great Effect, than the Hoe-plough could turn it up, and help in its Pulveration.

Dung, without Tillage, can do very little; with ſome Tillage doth ſomething; with much Tillage pulverizes the Soil in leſs time, than Tillage alone can do; but the Tillage alone, with more time, can pulverize as well: This the Experiments of *artificially* pulverizing of the pooreſt Land, as they are related by Mr. *Evelyn*, fully prove.

And theſe Experiments are the more to be depended on, as they are made both in *England* and *Holland* by Perſons of known Integrity.

This Truth is alſo further confirmed by thoſe Authors who have found, that High-way Duſt alone is a Manure preferable to Dung: And all theſe Pulverations being made by Attrition or Contuſion, why ſhould not our Inſtruments of Pulveration, in time, reduce a ſufficient Part of the Staple of a dry friable Soil, to a Duſt equal to that of a Highway?

The common Proportion of Dung uſed in the Field pulverizes only a ſmall Part of the Staple: but how long a time may be required for our Inſtruments to pulverize an equal Part, it depending much upon the Weather, and the Degree of Friability of the Soil, is uncertain.

I have ſeen ſurpriſing Effects from Ground, after being kept unexhauſted, by plowing with common Ploughs for Two whole Years running: and I am confident, that the Expence of this extraordinary Tillage and Fallow will not, in many Places, amount to above half the Expence of a Dreſſing with Dung; and if the Land be all the time kept in our Sort of little Ridges of the Size moſt proper for that Purpoſe, the Expence of plowing will be diminiſhed one Half; beſides the Advantage the Earth of ſuch Ridges hath, of being friable in Weather which is too moiſt for plowing the ſame Land on the Level.

I have made many Trials of fine *Dung* on the Rows; and, notwithſtanding the Benefit of it, I have, for theſe ſeveral Years laſt paſt, left it off, finding that a little more Hoeing will ſupply it at a much leſs Expence, than that of ſo ſmall a Quantity of Manure, and of the Hands neceſſary to lay it on, and of the Carriage.

CHAP. V.

Of TILLAGE.

TIllage is breaking and dividing the Ground by Spade, Plough, Hoe, or other Inſtruments, which divide by a ſort of Attrition (or Contuſion) as Dung does by Fermentation (a).

(a) *Neque enim aliud eſt Colere quam Reſolvere, & Fermentare Terram.* Columella.

And ſince the artificial Paſture of Plants is made and increas'd by Pulveration, 'tis no matter whether it be by the Ferment of *Dung*, the Attrition of the *Plough*, the Contuſion of the *Roller*; or by any other Inſtrument or Means whatſoever, except by Fire, which carries away all the Cement of that which is burnt.

By Dung we are limited to the Quantity of it we can procure, which in moſt Places is too ſcanty: But by Tillage, we can inlarge our Field of ſubterranean Paſture without Limitation, tho' the external Surface of it be confin'd within narrow Bounds: Tillage may extend the Earth's internal Superficies, in proportion to the Diviſion of its Parts; and as Diviſion is infinite, ſo may that Superficies be.

Every time the Earth is broken by any ſort of Tillage, or Diviſion, there muſt ariſe ſome new Superficies of the broken Parts, which never has been open before: For when the Parts of Earth are once united and incorporated together, 'tis morally impoſſible, that they, or any of them, ſhould be broken again, only in the ſame Places; for to do that, ſuch Parts muſt have again the ſame numerical Figures and Dimenſions they had before ſuch Breaking, which even by an infinite Diviſion could never be likely to happen: As the Letters of a Diſtichon, cut out and mixt, if they ſhould be thrown up never ſo often, would never be likely to fall into the ſame Order and Poſition with one another, ſo as to recompoſe the ſame Diſtich.

Although the internal Superficies may have been drain'd by a preceding Crop, and the next Plowing may move many of the before divided Parts, without new-breaking them; yet ſuch as are new-broken, have, at ſuch Places where they are ſo broken, a new Superficies, which never was, or did exiſt before; becauſe we cannot reaſonably ſuppoſe, that any of thoſe Parts can have in all Places (if in any Places) the ſame Figure and Dimenſions twice.

For as Matter is diviſible *ad infinitum*, the Places or Lines whereat 'tis ſo diviſible, muſt be, in relation to Number, infinite, that is to ſay, without Number; and muſt have at every Diviſion Superficies of Parts of infinite Variety *(b)* in Figure and Dimenſions.

And becauſe 'tis morally impoſſible, the ſame Figure and Dimenſions ſhould happen twice to any one Part, we need not wonder, how the Earth, every time of Tilling, ſhould afford a new internal Superficies (or artificial Paſture); and that the till'd Soil has in it an inexhauſtible Fund, which by a ſufficient Diviſion (being capable of an infinite one) may be produc'd.

Tillage (as well as Dung) is beneficial to all Sorts of Land *(c)*. Light Land, being naturally hollow, has larger Pores, which are the Cauſe of its Lightneſs: This, when it is by any means ſufficiently divided,

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(b) Their Variety is ſuch, that 'tis next to impoſſible, any Two Pieces, or Clods, in a Thouſand Acres of till'd Gronnd, ſhould have the ſame Figure, and equal Dimenſions; or that any Piece ſhould exactly tally with any other, except with that from whence it was broken off.

(*c*) 'Tis of late fully prov'd, by the Experience of many Farmers, that Two or Three additional Plowings, will ſupply the Place of Dung, even in the old Huſbandry, if they be perform'd at proper Seaſons; and the hiring Price of three Plowings, after Land has been thrice plow'd before, is but Twelve Shillings, whereas a Dunging will coſt Three Pounds: This was accidentally diſcovered in my Neighbourhood, by the Practice of a poor Farmer, who, when he had prepar'd his Land for Barley, and could not procure Seed to ſow it, plow'd it on till Wheat Seed-time, and (by means of ſuch additional Plowing) without Dung, had ſo good a Crop of Wheat, that it was judg'd to be more than the Inheritance of the Land it grew on.

The ſame Effect follows when they prepare Land for Turneps, ſince they are come in Faſhion, and ſow them ſeveral times upon ſeveral Plowings, the Fly as often taking them off; they have from ſuch extraordinary Tillage a good Crop of Wheat, inſtead of the loſt Turneps, without the Help of Dung; hence Double-plowing is now become frequent in this Country.

The Reaſon why Land is enrich'd by lying long unplow'd, is, that ſo very few Vegetables are carried off it, very little being produc'd; the Exhauſtion is leſs than what is added by the Atmoſphere, Cattle, &c. But when 'tis plow'd, a vaſtly greater Quantity of Vegetables is produc'd, and carried off, more than by the old Huſbandry is return'd to it.

the Parts being brought nearer together, becomes, for a time, Bulk for Bulk, heavier; *i. e.* The ſame Quantity will be contain'd in leſs Room, and ſo is made to partake of the Nature and Benefits of ſtrong Land, *viz.* to keep out too much Heat and Cold, and the like.

But ſtrong Land, being naturally leſs porous, is made for a time lighter (as well as richer) by a good Diviſion; the Separation of its Parts makes it more porous, and cauſes it to take up more room than it does in its natural State; and then it partakes of all the Benefits of lighter Land.

When ſtrong Land is plow'd, and not ſufficiently, ſo that the Parts remain groſs, 'tis ſaid to be rough, and it has not the Benefit of Tillage; becauſe moſt of the artificial Pores (or Interſtices) are too large; and then it partakes of the Inconveniencies of the hollow Land untill'd.

For, when the light Land is plow'd but once, that is not ſufficient to diminiſh its natural Hollowneſs (or Pores); and, for want of more Tillage, the Parts into which 'tis divided by that once (or perhaps twice) Plowing, remain too large; and conſequently the artificial Pores are large alſo, and, in that reſpect, are like the ill-till'd ſtrong Land.

Light-land, having naturally leſs internal Superficies, ſeems to require the more Tillage (*d*) or Dung to

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(*d*) As for puffy Land, which naturally ſwells up, inſtead of ſubſiding, tho' its Hollowneſs is much abated by Tillage, yet it is thought little better than barren Land, and unprofitable for Corn: But what we uſually call Light-land, is only comparatively ſo, in reſpect of that which is heavier and ſtronger. And this Sort of Light-land becomes much lighter by being ill-till'd; the unbroken Pieces of Turf underneath undiſſolved, forming large Cavities, increaſe its Hollowneſs, and conſequently its Lightneſs: I have often known this Sort of Land deſpis'd by its Owners, who fear'd to give it due Tillage, which they thought would make it ſo light, that the Wind would blow it away; but whenever ſuch has been thoroughly till'd, it never fail'd to become much to enrich it; as when the poor, hollow, thin Downs have their upper Part (which is the beſt) burnt, whereby all (except a *Caput Mortuum*) is carried away; yet the Salts of this ſpread upon that barren Part of the Staple, which is unburnt, divide it into ſo very minute Particles that their Paſture, will nouriſh Two or Three good Crops of Corn: But then the Plough, even with a conſiderable Quantity of Dung, is never able afterwards to make a Diviſion equal to what thoſe Salts have done; and therefore ſuch burnt Land remains barren.

Artificial Pores cannot be too ſmall, becauſe Roots may the more eaſily enter the Soil that has them, quite contrary to natural Pores; for theſe may be, and generally are, too ſmall, and too hard for the Entrance of all weak Roots, and for the free Entrance of ſtrong Roots.

Inſufficient Tillage leaves ſtrong Land with its natural Pores too ſmall, and its artificial ones too large. It leaves Light-land, with its natural and artificial Pores both too large.

Pores that are too ſmall in hard Ground, will not eaſily permit Roots to enter them.

Pores that are too large in any ſort of Land, can be of little other Uſe to Roots, but only to give them Paſſage to other Cavities more proper for them; and if in any Place they lie open to the Air, they are dry'd up, and ſpoil'd, before they reach them.

much ſtronger than before; and conſidering that 'tis till'd with leſs Expence than very ſtrong Land, it is, for ſeveral Sorts of Corn, found to be more profitable than Land of greater Strength and Richneſs, that is more difficult to be till'd.

And I am apt to think, that this Sort of Light-land acquires more Cement, by having its *external* Superficies often changed, and expoſed to the Dews, and other Benefits of the Atmoſphere, as well as by the Increaſe of (its *internal* Superficies, which is the Surfaces of all the divided Parts of Earth, or) the Paſture of Plants; the one being augmented by the other; *i. e.* that into the more Parts the Earth is broken, the more Cement will it attain, from the Sulphur, which is brought by the Dews.

For fibrous Roots (which alone maintain the Plant; the other Roots ſerve for receiving the Chyle from them, and convey it to the Stem) can take in no Nouriſhment from any Cavity, unleſs they come into Contact with (*e*), and preſs againſt, all the Superficies of that Cavity, which includes them; for it diſpenſes the Food to their Lacteals by ſuch Preſſure only: But a fibrous Root is not ſo preſs'd by the Superficies of a Cavity whoſe Diameter is greater than that of the Root.

The Surfaces of great Clods form Declivities on every Side of them, and large Cavities, which are as Sinks to convey, what Rain and Dew bring, too quickly downwards to below the plow'd Part.

The Firſt and Second plowings with common Ploughs ſcarce deſerve the Name of Tillage; they rather ſerve to prepare the Land for Tillage.

The Third, Fourth, and every ſubſequent plowing, may be of more Benefit, and leſs Expence, than any of the preceding ones.

(*e*) Roots cannot have any Nouriſhment from Cavities of the Earth that are too large to preſs againſt them, except what Water, when 'tis in great Quantity, brings to them, which is imbibed by the gentle Preſſure of the Water; but when the Water is gone, thoſe large Cavities being empty, the Preſſure ceaſes; and this is the Reaſon, that when Land has few other but ſuch large Cavities, the Plants in it always ſuffer more by dry Weather, than in Land which by Dung or Tillage has more minute and fewer large Cavities.

There may be ſome Moiſture on the Superficies of large Cavities; but without Preſſure the fibrous Roots cannot reach it; and very little or no Preſſure can be made to one Part of the Root's Superficies, unleſs the Whole that is included be preſſed.

If it be objected that a Charlock-Plant, when pulled up, and thrown upon the Ground, will grow thereon; this proves nothing againſt the Neceſſity of Preſſure, *&c.* for the Weight of that Plant preſſes ſome of its Roots ſo cloſely againſt the Ground, that they ſend out (unleſs the Weather be very dry) new Fibres into the Earth; and there they are preſſed in all their Superficies; without which Fibres the Plant doth not grow.

But the laſt Plowings will be more advantageouſly perform'd by way of Hoeing, as in the following Chapters will appear.

For the finer Land is made by Tillage, the richer will it become, and the more Plants it will maintain.

It has been often obſerv'd, that when Part of a Ground has been better till'd than the reſt, and the whole Ground conſtantly manag'd alike afterwards for Six or Seven Years ſucceſſively; this Part that was but once better till'd, always produc'd a better Crop than the reſt, and the Difference remain'd very viſible every Harveſt.

One Part being once made finer, the Dews did more enrich it; for they penetrate within and beyond the Superficies, whereto the Roots are able to enter: The fine Parts of the Earth are impregnate, throughout their whole Subſtance, with ſome of the Riches carried in by the Dews, and there repoſited; until, by new Tillage, the Inſides of thoſe fine Parts become Superficies; and as the Corn drains them, they are again ſupply'd as before; but the rough large Parts cannot have that Benefit; the Dews not penetrating to their Centres, they remain poorer.

I think nothing can be ſaid more ſtrongly to confirm the Truth of this, than what is related by the Authors quoted by Mr. *Evelyn (f)*, to this Effect, *viz.*

'Take of the moſt barren Earth you can find, 'pulverize it well, and expoſe it abroad for a Year, 'inceſſantly agitated *(g)*; it will become ſo fertile as 'to receive an exotic Plant from the furtheſt *Indies*; 'and to cauſe all Vegetables to proſper in the moſt 'exalted Degree, and to bear their Fruit as kindly 'with us as in their natural Climates.'

(f) In Pag. 17, 18, and 19. of his *Phil. Diſcourſe of Earth.*

(g) i. e. Stirr'd often.

This artificial Duſt (*b*), he ſays, will entertain Plants which refuſe Dung, and other violent Applications; and that it has a more nutritive Power than any artificial Dungs or Compoſt whatſoever: And further, that by this Toil of pulverizing, "'tis found, that Soil "may be ſo ſtrangely alter'd from its former Nature, "as to render the harſh and moſt uncivil Clay (*i*) "obſequious to the Huſbandmen, and to bring forth "Roots and Plants, which otherwiſe require the "lighteſt and holloweſt Mould (*k*).

'Tis to be ſuppos'd, that the *Indian* Plants had their due Degrees of Heat and Moiſture given them; and I ſhould not chuſe to beſtow this Toil upon the pooreſt of Earth in a Field or Garden, tho' that be the moſt ſure wherein to make the Experiment (*l*).

I never myſelf try'd this way of pounding or grinding, becauſe impracticable in the Fields.

But I have had the Experience of a Multitude of Inſtances, which confirm it ſo far, that I am in no

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(*b*) Tho' it may be impoſſible for the Plough to reduce the whole Staple into ſo fine Powder, yet the more internal Superficies it makes, the more Duſt will be made by the Atmoſphere in proportion; and great Clods perhaps are of no Uſe to Plants, but by that Duſt they let fall, being thence extricated by the inſenſible Ferment of the nitrous Air; and the Surfaces of this artificial Duſt muſt receive ſuch Operations from the Air, before the utmoſt Fertility be obtain'd.

(*i*) But I take harſh uncivil Clay to be the leaſt profitable of any to keep in Tillage.

(*k*) To this Duſt, *Namque hoc imitamur arando* ought to be apply'd, and not to *Putre ſolum*, which itſelf needs Tillage, as well as ſtrong Land: But it ſeems the Antients did not obſerve the Difference between natural Pores (or Hollowneſs) and artificial ones, tho' it is very great; as is ſhewn in Chap. of *Paſture of Plants*: Tis eaſier indeed to imitate this artificial Duſt in *hollow* than in *ſtrong* Land.

(*l*) This is the moſt proper Trial of the Effect of Pulveration by *pounding* and *grinding*; but Land may be ſo barren, that Plough or Spade may not be ſufficient to pulverize it to that Degree, which is neceſſary to give it the ſame Fertility, that pounding in a Mortar, or grinding betwixt Marbles (as Colours are ground), can.

Doubt, that any Soil *(m)* (be it rich or poor) can ever be made too fine by Tillage *(n)*.

For 'tis without diſpute, that one cubical Foot of this minute Powder may have more internal Superficies, than a thouſand cubical Feet of the ſame, or any other Earth till'd in the common Manner; and, I believe, no two arable Earths in the World do exceed one another in their natural Richneſs Twenty times; that is, One cubical Foot of the richeſt is not able to produce an equal Quantity of Vegetables, *cæteris paribus*, to Twenty cubical Feet of the pooreſt;

(*m*) Land that is too hollow and light, having no Cement to join its Parts together, tho' in Nature they are capable of infinite Diviſion, yet in Practice the Plough cannot divide them to any Purpoſe, unleſs they were firſt join'd, but glides through without breaking them; being more like to the primary Particles of Water againſt the Plough, which are broken by no Force, than to Earth; it may be moved, but not broken by Tillage, and therefore ought not to be reputed arable; nor does it indeed deſerve the Name of Land, but as the deſart Sands of *Libya*, to diſtinguiſh it from Sea.

(*n*) According to ſome, this Rule is only general, and not univerſal; for, ſay they, there's a ſort of binding Gravel, that, when it is made *fine*, will, by a ſudden Daſh of Rain, run together like a Metal; and I have ſeen the ſame Accident in a particular ſort of *white* Land; but this very rarely happens to the latter: I never knew it above once, and that was after Barley was ſown on it; the Hardneſs was only like a very thin Ice upon the Surface, which was ſome Hindrance to the Coming up of the Barley, until the Harrow's going over it once or twice broke that Ice or Cruſt, and then it came up very well.

I never had any other Sort of Land liable to this Misfortune; therefore can ſay nothing to the Gravel in that Caſe, nor how deep the *Conſtipation* may reach in it, nor what Remedy is moſt proper to prevent the ill Conſequence of it: But if there ſhould be two or three Exceptions out of *One thouſand Seventy-nine Millions One thouſand and Sixty different Sorts of* Earth (*ſee Mr. Evelyn's Terra*, p. 2.), 'twill be no great Matter.

But I think theſe are no real Exceptions againſt any Degree of *Pulverizing*; for it only ſhews, that ſome Sorts of Land, tho' very few, are ſubject by Accident to loſe too ſoon their Pulveration: And if the Fineneſs were no Benefit to that Land, ſuch Loſs of it would be no Injury to it.

therefore 'tis not ſtrange, that the pooreſt, when by pulverizing it has obtain'd One hundred times the internal Superficies of the rich untill'd Land, it ſhould exceed it in Fertility; or, if a Foot of the pooreſt was made to have Twenty times the Superficies of a Foot of ſuch rich Land, the pooreſt might produce an equal Quantity of Vegetables with the rich (*o*). Beſides, there is another extraordinary Advantage, when a Soil has a larger internal Superficies in a very little Compaſs; for then the Roots of Plants in it are better ſupply'd with Nouriſhment, being nearer to them on all Sides within Reach, than it can be when the Soil is leſs fine, as in common Tillage; and the Roots in the one muſt extend much further than in the other, to reach an equal Quantity of Nouriſhment: They muſt range and fill perhaps above Twenty times more Space to collect the ſame Quantity of Food.

But in this fine Soil, the moſt weak and tender Roots have free Paſſage to the utmoſt of their Extent, and have alſo an eaſy, due, and equal Preſſure everywhere, as in Water.

(*o*) And very poor Land, well pulveriz'd, will produce better Corn than very rich will do, without Manure or Tillage. The Experiment may be made by paring off the Turf, and ſetting Corn in the whole Ground that is very rich; and that will ſhew how much the natural Paſture of the rich is inferior to the artificial Paſture of the poor Land; but then the *poor* muſt have this Proportion of Exceſs of internal Superficies continued to it, during the whole Time of their Growth, which cannot be done without frequently repeated Diviſions of the Soil by Hoeing or Manure; elſe it might require Forty times the internal Superficies at the time of ſowing, to keep Twenty times the internal Superficies of the *rich* till Harveſt: For although the rich is continually loſing ſome of its artificial Paſture, as well as the *poor*, yet by loſing this equally, they ſtill draw nearer and nearer to the firſt Inequality of their natural Paſture.

But *poor* Land, being lighter, has this Advantage, that it being more *friable* than the ſtrong, requires leſs Labour to pulverize it; and therefore the Expence of it is much leſs, than in proportion to the Exceſs of Poorneſs of its internal Superficies.

Hard Ground makes a too great Reſiſtance, as Air makes a too little Reſiſtance, to the Superficies of Roots.

Farmers, juſt when they have brought their Land into a Condition fit to be further till'd to much greater Advantage, leave off, ſuppoſing the Soil to be fine enough, when, with the Help of Harrows, they can cover the Seed; and afterwards with a Roller they break the Clods; to the end that, if a Crop ſucceed, they may be able to mow it, without being hinder'd by thoſe Clods: By what I could ever find, this Inſtrument, call'd a Roller, is ſeldom beneficial to good Huſbands; it rather untills the Land, and anticipates the ſubſiding of the Ground, which in ſtrong Land happens too ſoon of itſelf (*p*).

But more to blame are they, who neglect to give their Land due Plowing, truſting to the Harrow to make it fine; and when they have thrown in their Seed, go over it Twenty times with the Harrows (*q*) till the Horſes have trodden it almoſt as hard as a Highway, which in moiſt Weather ſpoils the Crop; but on the contrary, the very Horſes, when the Earth is moiſt, ought all to tread in the Furrows only, as in plowing with a Hoe-plough they always do, when they uſe it inſtead of a common Plough.

(*p*) This Injury the Roller does, is only when 'tis uſed to preſs down the Earth after the Seed is ſown; and is the greater, if Land be moiſt; but the Rolling of it in dry Weather, when 'tis to be immediately plow'd up again, is the moſt ſpeedy Way to pulverize the Soil; and the Harrow is then very uſeful in pulling up the Clods, to the end that the Roller may the better come at them to cruſh them.

(*q*) *Nam veteres Romani dixerunt male ſubactum agrum, qui ſatis frugibus occandus ſit.*

Sed ut compluribus iterationibus ſic reſolvatur vervactum in pulverem, ut nullam vel exiguam deſideret occationem, cum ſeminaverimus. *Col.* Lib. 2. Cap. 4.

CHAP.

CHAP. VI.

Of HOEING.

HOEING is the breaking or dividing the Soil by Tillage, whilſt the Corn or other Plants are growing thereon.

It differs from common Tillage (which is always perform'd before the Corn or Plants are ſown or planted) in the times of performing it; 'tis much more beneficial; and 'tis perform'd by different Inſtruments.

Land that is before Sowing tilled never ſo much (tho' the more 'tis till'd the more it will produce) will have ſome Weeds, and they will come in along with the Crop for a Share of the Benefit of the Tillage, greater or leſs, according to their Number, and what Species they are of.

But what is moſt to be regarded is, that as ſoon as the Ploughman has done his Work of plowing and harrowing, the Soil begins to undo it, inclining towards, and endeavouring to regain, its natural ſpecific Gravity; the broken Parts by little and little coaleſce, unite, and loſe ſome of their Surfaces; many of the Pores or Interſtices cloſe up during the Seed's Incubation and Hatching in the Ground; and, as the Plants grow up, they require an Increaſe of Food proportionable to their increaſing Bulk; but on the contrary, inſtead thereof, that internal Superficies, which is their artificial Paſture, gradually decreaſes.

The Earth is ſo unjuſt to Plants, her own Off-ſpring, as to ſhut up her Stores in proportion to their Wants; that is, to give them leſs Nouriſhment when they have need of more: Therefore Man, for whoſe Uſe they are chiefly deſign'd, ought to bring in his reaſonable Aid for their Relief, and force open her Magazines with the Hoe, which will thence procure them at all times Proviſions in abundance, and alſo free them from Intruders; I mean, their ſpurious Kindred, the Weeds, that robb'd them of their too ſcanty Allowance.

There's no doubt, but that One-third Part of the Nouriſhment raiſed by Dung and Tillage, given to Plants or Corn at many proper Seaſons, and apportion'd to the different Times of their Exigencies, will be of more Benefit to a Crop, than the Whole apply'd, as it commonly is, only at the time of Sowing. This old Method is almoſt as unreaſonable as if Treble the full Stock of Leaves, neceſſary to maintain Silkworms till they had finiſhed their Spinning, ſhould be given them before they are hatched, and no more afterwards.

Next to Hoeing, and ſomething like it, is Tranſplanting, but much inferior; both becauſe it requires a ſo much greater Number of Hands, that by no Contrivance can it ever become general, nor does it ſucceed, if often repeated; but Hoeing will maintain any Plant in the greateſt Vigour 'tis capable of, even unto the utmoſt Period of Age. Beſides, there is Danger in removing a whole Plant, and Loſs of Time before the Plant can take Root again, all the former Roots being broken off at the Ends in taking up (for 'tis impoſſible to do it without), and ſo muſt wait until by the Strength and Virtue of its own Sap (which by a continual Perſpiration is daily enfeebled) new Roots are form'd, which, unleſs the Earth continue moiſt *(a)*, are ſo long in forming, that they not only find

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(a) But when the Earth doth continue moiſt, many tranſplanted Vegetables thrive better than the ſame Species planted in Seeds, becauſe the former, ſtriking Root ſooner, have a greater Advantage of the freſh-pulveriz'd Mould, which loſes ſome of its artificial Paſture before the Seeds have Roots to reach it. The ſame Advantage alſo have Seeds by ſoaking till ready to ſprout before they are planted. To both theſe the Moiſture of the Earth is neceſſary.

find a more difficult Reception into the cloſing Pores; but many times the Plant languiſhes and dies of an Atrophy, being ſtarv'd in the midſt of Plenty; but whilſt this is thus decaying, the hoed Plant obtains a more flouriſhing State than ever, without removing from the ſame Soil that produc'd it.

'Tis obſerv'd that ſome Plants are the worſe for Tranſplanting (*a*). *Fenochia* removed is never ſo good and tender as that which is not, it receives ſuch a Check in Tranſplanting in its Infancy; which, like the Rickets, leaves Knots that indurate the Parts of the Fennel, and ſpoil it from being a Dainty.

Hoeing has moſt of the Benefits without any Inconveniencies of Tranſplanting; becauſe it removes the Roots by little and little, and at different times; ſome of the Roots remaining undiſturb'd, always ſupply the moved Roots with Moiſture, and the whole Plant with Nouriſhment ſufficient to keep it from fainting, until the moved Roots can enjoy the Benefit of their new Paſture, which is very ſoon.

Another extraordinary Benefit of the new Hoing (*b*) Huſbandry is, that it keeps Plants moiſt in dry Weather, and this upon a double Account.

(*a*) As moſt long Tap-rooted Plants are; for I have often try'd the Tranſplanting of Plants, of *St. Foin* and *Luſerne*; and could never find, that any ever came near to the Perfection that thoſe will do which are not removed, being equally ſingle.

Tap-rooted Graſſes and Turneps are always injur'd by Tranſplanting; their long Root once broken off never arrives at the Depth it would have arriv'd unbroken; as for this Reaſon they cut off the Tap-root of an Apple-tree, to prevent its running downward, by which it would have too much Moiſture.

(*b*) Hoeing may be divided into Deep, which is our Horſe-hoeing, and Shallow, which is the Engliſh Hand-hoeing; and alſo the Shallow Horſe-hoeing, uſed in ſome Places betwixt Rows, where the Intervals are very narrow, as Sixteen or Eighteen Inches; this is but an Imitation of the Hand-hoe, or a *Succedaneum* to it; and can neither ſupply the Uſe of Dung, nor of Fallow, and may be properly called Scratch-hoeing.

Firſt, as they are better nouriſhed by Hoeing, they require leſs Moiſture, as appears by Dr. *Woodward*'s Experiment, that thoſe Plants which receive the greateſt Increaſe, having moſt terreſtrial Nouriſhment, carry off the leaſt Water in proportion to their Augment: So Barley or Oats, being ſown on a Part of a Ground very well divided by Dung and Tillage, will come up and grow vigorouſly without Rain, when the ſame Grains, ſown at the ſame time, on the other Part, not thus enriched, will ſcarce come up; or, if they do, will not thrive till Rain comes.

Secondly, The Hoe, I mean the Horſe-hoe (the other goes not deep enough), procures Moiſture to the Roots from the Dews, which fall moſt in dry Weather; and thoſe Dews (by what Mr. *Thomas Henſhaw* has obſerv'd) ſeem to be the richeſt Preſent the Atmoſphere gives to the Earth; having, when putrefy'd in a Veſſel, a black Sediment like Mud at the Bottom. This ſeems to cauſe the darkiſh Colour to the upper Part of the Ground. And the Sulphur, which is found in the Sediment of the Dew, may be the chief Ingredient of the Cement of the Earth; Sulphur being very glutinous, as Nitre is diſſolvent. Dew has both theſe.

Theſe enter in proportion to the Fineneſs and Freſhneſs of the Soil, and to the Quantity that is ſo made fine and freſh by the Hoe. How this comes to paſs, and the Reaſon of it, are ſhewn in the Chapter of Tillage.

To demonſtrate that Dews moiſten the Land when fine, dig a Hole in the hard dry Ground, in the drieſt Weather, as deep as the Plough ought to reach: Beat the Earth very fine, and fill the Hole therewith; and, after a few Nights Dews, you'll find this fine Earth become moiſt at the Bottom, and the hard Ground all round will continue dry.

Till a Field in Lands; make one Land very fine, by frequent deep Plowings; and let another be rough, by inſufficient Tillage, alternately; then plow the whole Field croſs-ways in the drieſt Weather, which has continued long; and you will perceive, by the Colour of the Earth, that every fine Land will be turn'd up moiſt; but every rough Land will be dry as Powder, from Top to Bottom.

Altho' hard Ground, when thoroughly ſoak'd with Rain, will continue wet longer than fine till'd Land adjoining to it; yet this Water ſerves rather to chill, than nouriſh the Plants ſtanding therein, and to keep out the other Benefits of the Atmoſphere, leaving the Ground ſtill harder when 'tis thence exhaled; and being at laſt once become dry, it can admit no more Moiſture, unleſs from a long-continued Deluge of Rain, which ſeldom falls till Winter, which is not the Seaſon for Vegetation.

As fine hoed Ground is not ſo long ſoaked by Rain, ſo the Dews never ſuffer it to become perfectly dry: This appears by the Plants, which flouriſh and grow fat in this, whilſt thoſe in the hard Ground are ſtarved, except ſuch of them, which ſtand near enough to the hoed *(a)* Earth, for the Roots to borrow Moiſture and Nouriſhment from it.

And

(a) As when Wheat is drill'd late in very poor Land, ſo that in the Spring the young Plants look all very yellow; let your Hoe-Plough, making a crooked Line, like an Indenture, on one ſide of a ſtrait Row of this poor Wheat in the Spring, turn a Furrow from it; and in a ſhort time you will ſee all thoſe yellow Plants, that are contiguous to this Furrow, change their yellow Colour to a deep Green; whilſt thoſe Plants of the ſame Row, which ſtand fartheſt off from this indented Furrow, change not their Colour till afterwards; and all the Plants change or retain their Colour ſooner or later gradually, as they ſtand nearer to, or farther from it; and the other Rows, which have no Furrow near them, continue their Yellow, after all this Row is become green and flouriſhing: But this Experiment is beſt to be made in poor ſandy Ground, when the Mould is friable; elſe perhaps the differ-

ent

And I have been informed by ſome Perſons, that they have often made the like Obſervations; that, in the drieſt of Weather, good Hoeing (*a*) procures Moiſture to Roots; tho' the Ignorant and Incurious fanſy, it lets in the Drought; and therefore are afraid to hoe their Plants at ſuch times, when, unleſs they water them, they are ſpoil'd for want of it.

There is yet one more Benefit Hoing gives to Plants, which by no Art can poſſibly be given to Animals: For all that can be done in feeding an Animal is, what has been here already ſaid of Hoing; that is, to give it ſufficient Food, Meat and Drink, at the times it has occaſion for them; if you give an Animal any more, 'tis to no manner of purpoſe, unleſs you could give it more Mouths, which is impoſſible;

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ent Colour may not appear until the Furrow be turn'd back to the Row, having lain ſome time to be ſomewhat pulveriz'd (or impregnated) by the Weather, *&c.*

This Experiment I often made on Wheat drill'd on the Level before I drill'd any on Ridges.

The plowing one Furrow in ſandy or mellow Ground makes a Pulveration, which is enjoy'd firſt by thoſe Plants that are the neareſt to it, and alſo delivers them from the Weeds, which, though they may be very few, yet there is a vaſt Difference between their robbing the Wheat of its Paſture in the Row, and the Wheat's enjoying both that and the whole Paſture of the Furrow alſo.

I never remember to have ſeen a Plant poor, that was contiguous to a well-hoed Interval, unleſs overpower'd by a too great Multitude of other Plants; and the ſame Exception muſt be made, if it were a Plant that required more or leſs Heat or Moiſture, than the Soil or Climate afforded.

(*a*) When Land is become hard by lying too long unho'd, the Plough in turning a deep Furrow from each Side of a ſingle Row of young Plants (ſuppoſe of Turneps) may crack the Earth quite through the Row, and expoſe the Roots to the open Air and Sun in very dry Weather; but if the Earth wherein the Plants ſtand be fine, there will be no Cracks in it: 'Tis therefore the delaying the Hoing too long that occaſions the Injury. But to hoe with Advantage againſt dry Weather, the Ground muſt have been well tilled or hoed before, that the Hoe may go deep; elſe the Dews, that fall in the Night, will be exhal'd back in the Heat of the Day.

ble; but in hoeing a Plant, the additional Nouriſhment thereby given, enables it to ſend out innumerable additional Fibres and Roots, as in one of the Glaſſes with a Mint in it, is ſeen; which fully demonſtrates, that a Plant increaſeth its Mouths, in ſome Proportion to the Increaſe of Food given to it: So that Hoeing, by the new Paſture it raiſes, furniſhes both Food and Mouths to Plants; and 'tis for want of Hoing, that ſo few are brought to their Growth and Perfection *(a)*.

In what manner the Sarrition of the Antients was performed in their Corn, is not very clear: This ſeems to have been their Method; *viz.* When the Plants were ſome time come up, they harrowed the Ground, and pull'd out the Weeds by Hand. The Proceſs of this appears in *Columella*, where he directs the Planting of *Medica* to be but a ſort of Harrowing or Raking amongſt the young Plants, that the Weeds might come out the more eaſily: *Ligneis Raſtris ſtatim jacta Semina obruantur. Poſt ſationem Ligneis Raſtris ſarriendus, & identidem runcandus eſt Ager, ne alterius generis Herba invalidam Medicam perimat.*

(a) A Ground was drill'd with Ray-graſs and Barley, in Rows at Five Inches Diſtance from each other; it produced a pretty good Crop of Ray-graſs the ſecond Year as is uſual; there was adjoining to it a Ground of Turneps, that were in Rows, with wide Intervals Horſe-ho'd; they ſtood for Seed; and amongſt them there was, in room of a Turnep, a ſingle Plant of Ray-graſs, which, being hoed as the Turneps were, had (in every one's Opinion that ſaw it) acquired a Bulk at leaſt equal to a Thouſand Plants of the ſame Species in the other Ground; tho' that vaſt Plant had no other Advantage above the other, except its Singleneſs, and the deep Hoeing.

I have ſeen a Chickweed, by the ſame means, as much increas'd beyond its common Size; and a Plant of Muſtard-ſeed, whoſe collateral Branches were much bigger than ever I ſaw a whole Plant of that ſort; it was higher than I could reach its Top, and indeed more like a Tree than an Herb; many other ſorts of Plants have I ſeen thus increas'd beyond what I had ever obſerv'd before, but none ſo much as thoſe.

They harrowed and hoed *Raſtris*; ſo that their *Occatio* and *Sarritio* were performed with much the ſame ſort of Inſtrument, and differed chiefly in the Time: The firſt was at Seed-time, to cover the Seed, or level the Ground; the other was to move the Ground after the Plants were up.

One ſort of their Sarrition was, *Segetes permota Terra debere adobrui, ut fruticare poſſint.* Another ſort was thus: *In Locis autem frigidis ſarriri nec adobrui, ſed plana Sarritione Terram permoveri.*

For the better underſtanding of theſe Two ſorts of Sarrition, we muſt conſider, that the Antients ſowed their Corn under Furrow; that is, when they had harrowed the Ground, to break the Clods, and make it level, they ſowed the Seed, and then plowed it in: This left the Ground very uneven, and the Corn came up (as we ſee it does here in the ſame caſe) moſtly in the loweſt Places betwixt the Furrows, which always lay higher: This appears by *Virgil*'s *Cum Sulcos æquant Sata*. Now, when they uſed *Plana Sarritio*, they harrowed Length-ways of the Furrows, which being ſomewhat harden'd, there could be little Earth thrown down thence upon the young Corn.

But the other ſort of Sarrition, whereby the Corn is ſaid *Adobrui*, to be cover'd, ſeems to be perform'd by Harrowing croſs the Furrows; which muſt needs throw down much Earth from the Furrows, which neceſſarily fell upon the Corn.

How this did contribute to make the Corn *fruticare*, is another Queſtion: I am in no doubt to ſay, it was not from covering any Part of it (for I ſee that has a contrary Effect), but from moving much Ground, which gave a new Paſture to the Roots: This appears by the Obſervation of the extraordinary Frutication of Wheat ho'd without being cover'd; and by the Injury it receives by not being uncover'd when any Earth falls on the Rows.

The ſame Author ſaith, *Faba, & cætera Legumina, cum quatuor Digitis à Terra extiterint, recte ſarrientur,* *excepto tamen Lupino, cujus Semini contraria eſt Sarritio; quoniam unam Radicem habet, quæ ſive Ferro ſucciſa ſeu vulnerata eſt, totus Frutex emoritur.*

If they had ho'd it only betwixt Rows, there had been no Danger of killing the Lupine, which is a Plant moſt proper for Hoeing. What he ſays of the Lupine's having no need of Sarrition, becauſe it is able of itſelf to kill Weeds, ſhews the Antients were Ignorant of the chief Uſe of Hoeing; *viz.* to raiſe new Nouriſhment by dividing the Earth, and making a new internal Superficies in it.

Sarrition ſcratched and broke ſo ſmall a Part of the Earth's Surface, amongſt the Corn and Weeds, without Diſtinction, or favouring one any more than the other, that it was a Diſpute, whether the Good it did in facilitating the Runcation (or Hand-weeding) was greater, than the Injury it did by bruiſing and tearing the Corn: And many of the Antients choſe rather to content themſelves with the Uſe of Runcation only, and totally to omit all Sarrition of their Corn.

But Hoeing is an Action very different from that of Sarrition, and is every way beneficial, no-way injurious to Corn, tho' deſtructive to Weeds. Therefore ſome modern Authors ſhew a profound Ignorance, in tranſlating *Sarritio*, Hoeing: They give an Idea very different from the true one: For the Antients truly hoed their Vineyards, but not their Corn; neither did they plant their Corn in Rows, without which they could not give it the Vineyard-hoeing: Their Sarculation was uſed but amongſt ſmall Quantities of ſown Corn, and is yet in Uſe for Flax; for I have ſeen the *Sarculum* (which is a ſort of a very narrow Hoe) uſed amongſt the Plants of Flax ſtanding irregularly: But this Operation is too tedious, and too chargeable, to be apply'd to great Quantities of irregular Corn.

If they ho'd their Crops ſown at random, one would think they ſhould have made mad Work of it; ſince they were not at the Pains to plant in Rows, and hoe betwixt them with their Bidens; being the Inſtrument with which they tilled many of their Vineyards, and enters as deep as the Plough, and is much better than the *Engliſh* Hoe, which indeed ſeems, at the firſt Invention of it, to be deſigned rather to ſcrape Chimneys, than to till the Ground.

The higheſt and loweſt Vineyards are ho'd by the Plough; firſt the high Vineyards, where the Vines grow (almoſt like Ivy) upon great Trees, ſuch as Elms, Maples, Cherry-trees, *&c.* Theſe are conſtantly kept in Tillage, and produce good Crops of Corn, beſides what the Trees do yield; and alſo theſe great and conſtant Products of the Vines are owing to this ſort of Hoe-tillage; becauſe neither in Meadow or Paſture Grounds can Vines be made to proſper; tho' the Land be much richer, and yet have a leſs Quantity of Graſs taken off it, than the Arable has Corn carried from that.

The Vines of low Vineyards *(a)*, ho'd by the Plough,

(*a*) From theſe I took my Vineyard Scheme, obſerving that indifferent Land produces an annual Crop of Grapes and Wood without Dung; and though there is annually carried off from an Acre of Vineyard, as much in Subſtance as is carried off in the Crop of an Acre of Corn produced on Land of equal Goodneſs; and yet the Vineyard Soil is never impoveriſhed, unleſs the hoeing Culture be denied it: But a few annual Crops of Wheat, without Dung, in the common Management, will impoveriſh and emaciate the Soil.

The Vine indeed has the Advantage of being a large perennial Plant, and of receiving ſome Part of its Nouriſhment below the Staple; but it has alſo Diſadvantages: The Soil of the Vineyard never can have a true Summer Fallow, tho' it has much Summer Hoeing; for the Vines live in it, and all over it all the Year: neither can that Soil have Benefit from Dung, becauſe though by increaſing the Pulveration, it increaſes the Crop, yet it ſpoils the Taſte of the Wine; the Exhauſtion of that Soil is therefore ſupply'd by no artificial Help but Hoeing: And by all the Experience I have had of it, the ſame Cauſe will have the ſame Effect upon a Soil for the Production of Corn, and other Vegetables, as well as upon the Vineyard.

Plough, have their Heads juſt above the Ground, ſtanding all in a moſt regular Order, and are conſtantly plowed in the proper Seaſon: Theſe have no other Aſſiſtance, but by Hoeing; becauſe their Head and Roots are ſo near together, that Dung would ſpoil the Taſte of the Wine they produce, in hot Countries.

All Vineyards muſt be ho'd one way or other (*a*), or elſe they will produce nothing of Value; but Corn-fields without Hoeing do produce ſomething, tho' nothing in Compariſon to what they would do with it.

Mr. *Evelyn* ſays, that when the Soil, wherein Fruit-trees are planted, is conſtantly kept in Tillage, they grow up to be an Orchard in half the Time they would do, if the Soil were not till'd; and this keeping an Orchard-Soil in Arable, 'is Horſe-hoing it.

In ſome Places in *Berkſhire* they have uſed, for a long time, to Hand-hoe moſt ſorts of Corn, with very great Succeſs; and I may ſay this, that I myſelf never knew, or heard, that ever any Crop of Corn was properly ſo ho'd, but what very well anſwer'd the Expence, even of this Hand-work; but be this never ſo profitable, there are not a Number of Hands to uſe it in great Quantities; which poſſibly was one Reaſon the Antients were not able to introduce it into their Corn-fields to any purpoſe; tho' they ſhould not have been ignorant of the Effect of it, from what they ſaw it do in their Vineyards and Gardens.

In the next Place I ſhall give ſome general Directions, which by Experience I have found neceſſary to be known, in order to the Practice of this Hoing-Huſbandry.

I. *Concerning the Depth to plant at.*
II. *The Quantity of Seed to plant.*
III. *And the Diſtance of the Rows.*

(*a*) Vines, that cannot be ho'd by the Plough, are ho'd by the Bidens.

I. 'Tis neceſſary to know how deep we may plant our Seed, without Danger of burying it; for ſo 'tis ſaid to be, when laid at a Depth below what 'tis able to come up at.

Different Sorts of Seeds come up at different Depths; ſome at ſix Inches, or more; ſome at not more than half an Inch: The way to know for certain the Depth any ſort will come up at is, to make Gauges in this manner: Saw off 12 Sticks of about 3 Inches Diameter: Bore a Hole in the End of each Stick, and drive into it a taper Peg; let the firſt Peg be half an Inch long, the next an Inch, and ſo on; every Peg to be half an Inch longer than the former, till the laſt Peg be Six Inches long; then in that ſort of Ground where you intend to plant, make a Row of Twenty Holes with the Half-inch Gauge; put therein Twenty good Seeds; cover them up, and ſtick the Gauge at the End of that Row; then do the like with all the other Eleven Gauges: This will determine the Depth, at which the moſt Seeds will come up (*a*).

When the Depth is known, wherein the Seed is ſure to come up, we may eaſily diſcover whether the Seed be good or not, by obſerving how many will fail: For in ſome ſorts of Seeds the Goodneſs cannot be known by the Eye; and there has been often great Loſs by bad Seed, as well as by burying good Seed; both which Misfortunes might be prevented by this little Trouble; beſides, 'tis not convenient to plant ſome ſorts of Seed at the utmoſt Depth they

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(*a*) In the common way of Sowing 'tis hard to know the proper Depth, becauſe ſome Seeds lying deep, and others ſhallow, it is not eaſy to diſcover the Depth of thoſe that are buried: But I have found in drilling of black Oats, that when the Drill-Plough was ſet a little deeper for Trial, very few came up: Therefore 'tis proper for the Driller to uſe the Gauges for all ſorts of Seeds; for, if he drills them too deep, he may loſe his Crop; or, if too ſhallow, in dry Weather, he may injure it, eſpecially in Summer Seeds; but for thoſe planted againſt Winter, there is the moſt Damage by planting too deep.

will come up at; for it may be ſo deep, as that the Wet may rot or chill the firſt Root, as in Wheat in moiſt Land.

The Nature of the Land, the Manner how it is laid, either flat, or in Ridges, and the Seaſon of Planting, with the Experience of the Planter, acquired by ſuch Trials, muſt determine the proper Depths for different Sorts of Seeds.

II. The proper Quantity of Seed to be drill'd on an Acre, is much leſs than muſt be ſown in the common way; not becauſe Hoeing will not maintain as many Plants as the other; for, on the contrary, Experience ſhews it will, *cæteris paribus*, maintain more; but the Difference is upon many other Accounts: As that 'tis impoſſible to ſow it ſo even by Hand, as the Drill will do; for let the Hand ſpread it never ſo exactly (which is difficult to do ſome Seeds, eſpecially in windy Weather), yet the Unevenneſs of the Ground will alter the Situation of the Seed; the greateſt Part rebounding into the Holes, and loweſt Places; or elſe the Harrows, in Covering, draw it down thither; and tho' theſe low Places may have Ten times too much, the high Places may have little or none of it: This Inequality leſſens, in effect, the Quantity of the Seed; becauſe Fifty Seeds, in room of One, will not produce ſo much as One will do; and where they are too thick, they cannot be well nouriſhed, their Roots not ſpreading to near their natural Extent, for want of Hoeing to open the Earth. Some Seed is buried (by which is meant the laying them ſo deep, that they are never able to come up, as *Columella* cautions, *Ut abſque ulla Reſurrectionis Spe ſepeliantur*): Some lies naked above the Ground; which, with more uncovered by the firſt Rain, feeds the Birds and Vermin.

Farmers know not the Depth that is enough to bury their Seed, neither do they make much Difference in the Quantity they ſow on a rough, or a fine Acre; tho' the ſame that is too little for the one, is too much for the other; 'tis all mere Chance-work, and they put their whole Truſt in good Ground, and much Dung, to cover their Errors.

The greateſt Quantity of Seed I ever heard of to be uſually ſown, is in *Wiltſhire*, where I am informed by the Owners themſelves, that on ſome ſorts of Land they ſow Eight Buſhels of Barley to an Acre; ſo that if it produce Four Quarters to an Acre, there are but Four Grains for One that is ſown, and is a very Poor Increaſe, tho' a good Crop; this is on Land plowed once, and then double-dung'd, the Seed only harrow'd into the ſtale and hard Ground *(a)*, 'tis like not Two Buſhels of the Eight will enter it to grow; and I have heard, that in a dry Summer an Acre of this ſcarce produces Four Buſhels at Harveſt.

But, in Drilling, Seed lies all the ſame juſt Depth; none deeper, nor ſhallower, than the reſt; here's no Danger of the Accidents of burying, or being uncover'd, and therefore no Allowance muſt be made for them; but Allowance muſt be made for other Accidents, where the ſort of Seed is liable to them; ſuch as Grub, Fly, Worm, Froſt, *&c.*

Next, when a Man unexperienc'd in this Method has proved the Goodneſs of his Seed, and Depth to plant it at, he ought to calculate what Number of Seeds a Buſhel, or other Meaſure or Weight, contains: For one Buſhel, or one Pound of ſmall Seed, may contain double the Number of Seeds, of a Buſhel, or a Pound, of large Seed of the ſame Species.

This Calculation is made by weighing an Ounce, and counting the Number of Seeds therein; then weighing a Buſhel of it, and multiplying the Number of Seeds of the Ounce, by the Number of Ounces

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(*a*) Stale Ground is that which has lain ſome conſiderable time after Plowing, before it is ſown, contrary to that which is ſown immediately after plow'd; for this laſt is generally not ſo hard as the former.

of the Buſhel's Weight; the Product will ſhew the Number of Seeds of a Buſhel near enough: Then, by the Rule of Three, apportion them to the ſquare Feet of an Acre; or elſe it may be done, by divideing the Seeds of the Buſhel by the ſquare Feet of an Acre; the Quotient will give the Number of Seeds for every Foot: Alſo conſider how near you intend to plant the Rows, and whether Single, Double, Treble, or Quadruple; for the more Rows, the more Seed will be required *(a)*.

Examine what is the Produce of one middle-ſiz'd Plant of the Annual, but the Produce of the beſt and largeſt of the perennial Sort; becauſe that by Hoeing will be brought to its utmoſt Perfection: Proportion the Seed of both to the reaſonable Product; and, when 'tis worth while, adjuſt the Plants to their competent Number with the Hand-hoe, after they are up; and plant Perennials generally in ſingle Rows: Laſtly, Plant ſome Rows of the Annual thicker than others, which will ſoon give you Experience (better than any other Rule) to know the exact Quantity of Seed to drill.

III. The Diſtances of the Rows are one of the moſt material Points, wherein we ſhall find many apparent Objections againſt the Truth; of which tho' full Experience be the moſt infallible Proof, yet the World is by falſe Notions ſo prejudiced againſt wide Spaces between Rows, that unleſs theſe common (and I wiſh I could ſay, only vulgar) Objections be firſt anſwer'd, perhaps no-body will venture ſo far out of the old Road, as is neceſſary to gain the Experience; without it be ſuch as have ſeen it.

(a) The narrow Spaces (ſuppoſe Seven Inches) betwixt Double, Treble, or Quadruple Rows, the Double having One, the Treble Two, and the Quadruple Three of them, are called *Partitions*.

The wide Space (ſuppoſe of near Five Feet) betwixt any Two of theſe Double, Treble, or Quadruple Rows, is call'd an *Interval*.

I formerly was at much Pains, and at ſome Charge, in improving my Drills, for planting the Rows at very near Diſtances; and had brought them to ſuch Perfection, that One Horſe would draw a Drill with Eleven Shares, making the Rows at Three Inches and half Diſtance from one another; and at the ſame time ſow in them Three very different Sorts of Seeds, which did not mix; and theſe too, at different Depths; as the Barley-Rows were Seven Inches aſunder, the Barley lay Four Inches deep; a little more than Three Inches above that, in the ſame Chanels, was Clover; betwixt every Two of theſe Rows was a Row of St. Foin, cover'd half an Inch deep.

I had a good Crop of Barley the firſt Year; the next Year, Two Crops of Broad-Clover, where that was ſown; and where Hop-Clover was ſown, a mix'd Crop of That and St. Foin, and every Year afterwards a Crop of St. Foin; but I am ſince, by Experience, ſo fully convinced of the Folly of theſe, or any other ſuch mix'd Crops, and more eſpecially of narrow Spaces, that I have demoliſh'd theſe Inſtruments (in their full Perfection) as a vain Curioſity, the Drift and Uſe of them being contrary to the true Principles and Practice of Horſe-Hoeing.

Altho' I am ſatisfied, that every one, who ſhall have ſeen as much of it as I have, will be of my Mind in this Matter; yet I am aware, that what I am going to advance, will ſeem ſhocking to them, before they have made Trials.

I lay it down as a Rule (to myſelf) that every Row of Vegetables, to be Horſe-ho'd, ought to have an empty Space or Interval of Thirty Inches on one Side of it *(a)* at leaſt, and of near Five Feet in all Sorts of Corn.

(*a*) *Note*, We call it one Row, tho' it be a Double, Treble, or Quadruple Row; becauſe when they unite in the Spting, they ſeem to be all ſingle; even the Quadruple then is but as one ſingle Row.

In Hand-hoeing there is always leſs Seed, fewer Plants, and a greater Crop, *cæteris paribus*, than in the common Sowing: Yet there, the Rows muſt be much nearer together, than in Horſe-hoeing; becauſe as the Hand moves many times leſs Earth than the Horſe, the Roots will be ſent out in like Proportion; and if the Spaces or Intervals, where the Hand-hoe only ſcratches a little of the upper Surface of them, ſhould be wide, they would be ſo hard and ſtale underneath, that the Roots of perennial Plants would be long in running thro' them; and the Roots of many annual Plants would never be able to do it.

An Inſtance which ſhews ſomething of the Difference between Hand-hoeing and Deep-hoeing is, That a certain poor Man is obſerv'd to have his Cabbages vaſtly bigger than any-body's elſe, tho' their Ground be richer, and better dung'd: His Neighbours were amaz'd at it, till the Secret at length came out, and was only this: As other People ho'd their Cab-

Obſerve, that as wide Intervals are neceſſary for perfect Horſe-hoeing, ſo the largeſt Vegetables have generally the greateſt Benefit by them; tho' ſmall Plants may have conſiderable Benefit from much narrower Intervals than Five Feet.

The Intervals may be ſomewhat narrower for conſtant annual Crops of Barley, than of Wheat; becauſe Barley does not ſhut out the Hoe-Plough ſo ſoon, nor require ſo much Room for Hoeing, nor ſo much Earth in the Intervals, it being a leſſer Plant, and growing but about a Third-part of the Time on the Ground; but he that drills Barley, muſt reſolve to reap it, and bind it up in Sheaves; for if he mows it, or does not bind it, a great Part will be loſt among the Earth in the Intervals: But 'tis now found, that in a wet Harveſt the beſt way is not to bind up drill'd Barley or Oats; but, inſtead thereof, to make up the Grips into little Heaps by Hands, laying the Ears upon one another inwards, and the Stubble-ends outwards; ſo that with a Fork that hath Two Fingers, and a Thumb, 'tis very eaſy to pitch ſuch Heaps up the Waggons without ſcattering, or waſting any of the Corn.

'Tis alſo ſeen, that when the Reapers take care to ſet their Grips with the But-ends in the Bottoms of the Intervals, and the Ears properly on the Stubble, they will ſo ſtand up from the Ground, as to eſcape much better from ſprouting, than mow'd Corn.

bages with a Hand-hoe, he inſtead thereof dug his with a Spade: And nothing can more nearly equal (*a*) the Uſe of the Horſe-hoe than the Spade does.

And when Plants have never ſo much *Pabulum* near them, their fibrous Roots cannot reach it all, before the Earth naturally excludes them from it; for, to reach it all, they muſt fill all the Pores (*b*), which is impoſſible: So far otherwiſe it is, that we ſhall find it probable, that they can only reach the leaſt Part of it, unleſs the Roots could remove themſelves from Place to Place, to leave ſuch Pores as they had exhauſted, and apply themſelves to ſuch as were unexhauſted; but they not being endow'd with Parts neceſſary for local Motion (as Animals are), the Hoe-Plough ſupplies their want of Feet; and both conveys them to their Food, and their Food to them, as well as provides it for them; for by tranſplanting the Roots, it gives them Change of the Paſture, which it increaſes by the very Act of changing them from one Situation to another, if the Intervals be wide enough for this Hoeing Operation to be properly perform'd.

The Objections moſt likely to prepoſſeſs Peoples Minds, and prevent their making Trials of this Huſbandry, are theſe:

Firſt, They will be apt to think, that theſe wide, naked Spaces, not being cover'd by the Plants, will not be ſufficient to make a good Crop.

For Anſwer, we muſt conſider, that tho' Corn, ſtanding irregular and *ſparſim*, may ſeem to cover

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(*a*) The Hoe-Plough exceeds the Spade in this reſpect, that it removes more of the Roots, and cuts off fewer; which is an Advantage when we till near to the Bodies of Plants that are grown large.

(*b*) The Roots of a Mint, ſet a whole Summer in a Glaſs, kept conſtantly repleniſhed with Water, will, in Appearance, fill the whole Cavity of the Glaſs; but by compreſſing the Roots, or by obſerving how much Water the Glaſs will hold when the Roots are in it, we are convinc'd, that they do not fill a Fourth-part of its Cavity; tho' they are not ſtopp'd by Water, as they are by Earth.

the Ground better than when it ſtands regular in Rows, this Appearance (*a*) is a mere *Deceptio viſus*; for Stalks are never ſo thick on any Part of the Ground as where many come out of one Plant, or as when they ſtand in a Row; and a ho'd Plant of Corn will have Twenty or Thirty Stalks (*b*), in the ſame Quantity of Ground where an un-ho'd Plant, being equally ſingle, will have only Two or Three Stalks. Theſe tillered ho'd Stalks, if they were planted *ſparſim* all over the Interval, it might ſeem well cover'd, and perhaps thicker than the ſown Crop commonly is; ſo that tho' theſe ho'd Rows ſeem to contain a leſs Crop, they may contain, in reality, a greater Crop than the ſown, that ſeems to exceed it; and 'tis only the different placing that makes one ſeem greater, and the other leſs, than it really is; and this is only when both Crops are young.

The next Objection is, That the Space or Interval not being *planted*, much of the Benefit of that Ground will be loſt; and therefore the Crop muſt be leſs than if it were planted all over.

I anſwer, It might be ſo, if not Horſe-ho'd; but if well Horſe-ho'd, the Roots can run through the Intervals; and, having more Nouriſhment, make a greater Crop.

The too great Number of Plants, plac'd all over the Ground in common ſowing, have, whilſt it is open, an Opportunity of *waſting*, when they are very young, that Stock of Proviſion, for want of which the greateſt Part of them are afterwards ſtarv'd; for

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(*a*) For the Eye to make a Compariſon betwixt a ſown Crop and ſuch a ho'd Crop, it ought, when 'tis half-grown, to look on the ho'd Crop acroſs the Rows; becauſe in the other it does ſo, in effect, which Way ſoever it looks; but whatever Appearance the ho'd Crop of Vegetables (of as large a Species as Wheat) makes when young, it ſurely, if well managed, appears more beautiful at Harveſt than a ſown Crop.

(*b*) I have counted Fifty large Ears on one ſingle ho'd Plant of Barley.

their irregular Standing prevents their being relieved with freſh Supplies from the Hoe: Hence it is, that the old Method exhauſting the Earth to no purpoſe, produces a leſs Crop; and yet leaves leſs *Pabulum* behind for a ſucceeding one, contrary to the Hoeing-Huſbandry, wherein Plants are manag'd in all reſpects by a quite different Oeconomy.

In a large Ground of Wheat it was prov'd, that the wideſt ho'd Intervals brought the greateſt Crop of all: Dung without Hoeing did not equal Hoeing without Dung. And, what was moſt remarkable, amongſt Twelve Differences of wider and narrower Spaces, more and leſs ho'd, dung'd and undung'd, the Hand-ſow'd was conſiderably the worſt of all; tho' all the Winter, and Beginning of the Spring, that made infinitely the moſt promiſing Appearance; but at Harveſt yielded but about One-fifth Part of Wheat of that which was moſt hoed; there was ſome of the moſt hoed, which yielded Eighteen Ounces of clean Wheat in a Yard in Length of a double Row, the Intervals being Thirty Inches, and the Partition Six Inches (*a*).

A Third Objection like the two former is, that ſo ſmall a Part of the Ground, as that whereon the Row ſtands, cannot contain Plants or Stalks ſufficient for a full Crop.

This ſome Authors endeavour to ſupport by Arguments taken from the perpendicular Growth of Vegetables, and the Room they require to ſtand on; both which having anſwer'd elſewhere, I need not ſay much of them here; only I may add, that if Plants could be brought to as great Perfection, and ſo to

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(*a*) The ſame Harveſt, a Yard in Length of a double Row of Barley, having Six Inches Partition, produc'd Eight hundred and Eighty Ears in a Garden; but the Grains happen'd to be eaten by Poultry before 'twas ripe, ſo that their Produce of Grains could not be known: One like Yard of a ho'd Row of Wheat, in an undung'd Field, produc'd Four hundred Ears of Lammas-Wheat.

ſtand as thick all over the Land, as they do in the ho'd Rows, there might be produc'd, at once, many of the greateſt Crops of Corn that ever grew.

But ſince Plants thrive, and make their Produce, in proportion to the Nouriſhment they have within the Ground, not to the Room they have to ſtand upon it, one very narrow Row may contain more Plants than a wide Interval can nouriſh, and bring to their full Perfection, by all the Art that can be uſed; and 'tis impoſſible a Crop ſhould be loſt for want of room to ſtand above the Ground, tho' it were leſs than a Tenth-part of the Surface *(a)*.

In wide Intervals there is another Advantage of Hoeing, I mean Horſe-hoeing (the other being more like Scratching and Scraping than Hoeing): There is room for many Hoeings *(b)*, which muſt not come very

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(a) Mr. *Houghton* calculates, that a Crop of Wheat of Thirty Quarters to an Acre, each Ear has two Inches and a Half of Surface; by which 'tis evident, that there wou'd be room for many ſuch prodigious Crops to ſtand on.

And a Quick-hedge, ſtanding between two Arable Grounds, one Foot broad at Bottom, and Eighteen Feet in Length, will, at Fourteen Years Growth, produce more of the ſame ſort of Wood, than Eighteen Feet ſquare of a Coppice will produce in the ſame time, the Soil of both being of equal Goodneſs.

This ſeems to be the ſame Caſe with our ho'd Rows; the Coppice, if it were to be cut in the Firſt Years, would yield perhaps Ten times as much Wood, as the Hedge; but many of the Shoots of the Coppice conſtantly die every Year, for want of ſufficient Nouriſhment, until the Coppice is fit to be cut; and then its Product is much leſs than that of the Hedge, whoſe Paſture has not been over-ſtock'd to ſuch a degree as the Coppice-Paſture has been; and therefore brings its Crop of Wood to greater Perfection than the Coppice-Wood, which has Eighteen times the Surface of Ground to ſtand on: The Hedge has the Benefit of Hoeing, as oft as the Land on either ſide of it is till'd; but the Coppice, like the ſown Corn, wants that Benefit.

(b) Many Hoeings; but if it ſhould be aſked how many, we may take *Columella*'s Rule in hoeing the Vines, *viz. Numerus autem vertendi Soli (bidentibus) definiendus non eſt, cum quanto cre-*

very near the Bodies of ſome annual Plants, except whilſt they are young; but, in narrow Intervals, this cannot be avoided at every Hoeing: 'Tis true, that in the laſt Hoeings, even in the middle of a large Interval, many of the Roots may be broken off by the Hoe-plough, at ſome conſiderable Diſtance from the Bodies; but yet this is no Damage, for they ſend out a greater Number of Roots than before; as in the Mint, in Chap. I. appears.

In wide Intervals, thoſe Roots are broken off only where they are ſmall; for tho' they are capable of running out to more than the Length of the external Parts of a Plant; yet 'tis not neceſſary they ſhould always do ſo; if they can have ſufficient Food nearer to the Bodies *(a)* of the Plants.

And theſe new, young, multiply'd Roots are fuller of Lacteal Mouths than the older ones; which makes it no Wonder, that Plants ſhould thrive faſter by having ſome of their Roots broken off by the Hoe; for as Roots do not enter every Pore of the Earth, but miſs great Part of the Paſture, which is left unexhauſted, ſo when new Roots ſtrike out from the broken Parts of the old, they meet with that Paſture, which their Predeceſſors miſs'd, beſides that new Paſture which the Hoe raiſes for them; and thoſe Roots which the Hoe pulls out without breaking,

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brior ſit, plus prodeſſe foſſionem conveniat. Sed impenſarum ratio modum poſtulat. Lib. 4. Cap. 5.

Neither is it altogether the Number of Hoeings that determines the Degrees of Pulveration: For, Once well done, is Twice done; and the oftener the better, if the Expence be not exceſſive.

Poor Land, be it never ſo light, ſhould have the moſt Hoeings; becauſe Plants, receiving but very little Nouriſhment from the natural Paſture of ſuch Land, require the more artificial Paſture to ſubſiſt on.

(a) All the Mould is never ſo near to the Bodies of Plants, as 'tis when the Row ſtands on a high Six-feet Ridge, when the middle of the Interval is left bare of Earth, at the laſt Hoeing; for then all the Mould may be but about a Foot, or a Foot and half, diſtant from the Body of each Plant of a Treble Row.

and covers again, are turn'd into a freſh Paſture; ſome broken, and ſome unbroken: All together invigorate the Plants.

Beſides, the Plants of ſown Corn, being treble in Number to thoſe of the drill'd, and of equal Strength and Bulk, whilſt they are very young, muſt exhauſt the Earth whilſt it is open, thrice as much as the drill'd Plants do; and before the ſown Plants grow large, the Pores of the Earth are ſhut againſt them, and againſt the Benefit of the Atmoſphere; but for the drill'd, the Hoe gives conſtant Admiſſion to that Benefit; and if the Hoe procures them (by dividing the Earth) Four times the Paſture of the ſown during their Lives, and the Roots devour but one half of that, then tho' the ho'd Crop ſhould be double to the ſown, yet it might leave twice as much *Pabulum* for a ſucceeding Crop. 'Tis impoſſible to bring theſe Calculations to Mathematical Rules; but this is certain in Practice, that a ſown Crop, ſucceeding a large undung'd ho'd Crop, is much better than a ſown Crop, that ſucceeds a ſmall dung'd ſown Crop. And I have the Experience of poor, worn out Heath-ground, that, having produc'd Four ſucceſſive good ho'd Crops of Potatoes (the laſt ſtill beſt), is become tolerable good Ground.

In a very poor Field were planted Potatoes, and, in the very worſt Part of it, ſeveral Lands had them in Squares a Yard aſunder; theſe were plowed four ways at different times: Some other Lands adjoining to them, of the very ſame Ground, were very well dung'd and till'd; but the Potatoes came irregularly, in ſome Places thicker, and in others thinner: Theſe were not ho'd, and yet, at firſt coming up, looked blacker and ſtronger than thoſe in Squares not dung'd, either that Year, or ever, that I know of; yet theſe Lands brought a good Crop of the largeſt Potatoes, and very few ſmall ones amongſt them; but in the dung'd Lands, for want of Hoeing, the Potatoes were not worth the taking up; which proves, that in thoſe Plants that are planted ſo as to leave Spaces wide enough for Repetitions of Hoeing, that Inſtrument can raiſe more Nouriſhment to them, than a good Coat of Dung with common Tillage.

Another thing I have more particularly obſerv'd, *viz.* That the more ſucceſſive Crops are planted in wide Intervals, and often ho'd, the better the Ground does maintain them; the laſt Crop is ſtill the beſt, without Dung, or changing the ſort of Plant; and this is viſible in Parts of the ſame Field, where ſome Part has a firſt, ſome other Part a ſecond, the reſt a third Crop growing all together at the ſame time; which ſeems to prove, that as the Earth is made by this Operation to diſpenſe or diſtribute her Wealth to Plants, in proportion to the Increaſe of her inner Superficies (which is the Paſture of Plants); ſo the Atmoſphere, by the Riches in Rain and Dews, does annually reimburſe her in proportion to the ſame Superficies, with an Overplus for Intereſt: But if that Superficies be not increaſed to a competent degree, and, by frequent Repetitions of Hoeing, kept increaſing (which never happens in common Huſbandry) this Advantage is loſt; and, without often repeated Stercoration, every Year's Crop grows worſe; and it has been made evident by Trials, which admit of no Diſpute, that Hoeing, without Dung or Fallow, can make ſuch Plants as ſtand in wide Intervals, more vigorous in the ſame Ground, than both common Dunging and Fallowing can do without Hoeing.

This ſort of Hoeing has in truth every Year the Effect of a Summer-fallow; tho' it yearly produce a good Crop.

This is one Reaſon of the different Effects Plants have upon the Soil; ſome are ſaid to enrich it, others to burn it, *i. e.* to impoveriſh it; but I think it may be obſerved, that all thoſe Plants, which are uſually ho'd, are reckoned among the Enrichers;

and tho' it be certain, that ſome Species of Plants are, by the Heat of their Conſtitution, greater Devourers than thoſe of another Species of equal Bulk; yet there is Reaſon to believe, that were the moſt cormorant Plant of them all to be commonly ho'd, it would gain (*a*) the Reputation of an Enricher or

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(*a*) But this muſt be intended of the deep Horſe-hoeing; for Turneps that ſtand for Seed, are ſuch Devourers, and feed ſo long on the Soil, that tho' they are Hand-ho'd, ſuch a ſhallow Operation doth not ſupply the uſual Thickneſs of thoſe Plants with Paſture ſufficient to raiſe their Stems to half their natural Bulk; and they leave ſo little of that Paſture behind them, that the Soil is obſerv'd to be extremely impoveriſhed for a Year or two, and ſometimes three Years after them; but 'tis otherwiſe with my Horſe-ho'd Turnep-ſeed; for I never fail'd of a good Crop of Barley after it, ſown on the Level in the following Spring, tho' no Dung hath been uſed on the Land where the Turnep ſeed grew for many Years. And alſo my Barley crops thus ſown after two ſucceſſive Crops of Turnep-ſeed without a Fallow between them, are as good as thoſe ſown after a ſingle Crop of it. For I have ſeveral times made theſe Turnep-ſeed Crops annual, that is, to have Two Crops of it in Two Years, which would in the old way require Three Years, becauſe this Crop ſtands about a Year on the Ground, and is not ripe till Midſummer, which is too late to get that Land into a Tilth proper to plant another Seed-crop on it the ſame Summer; neither can the Soil be able to bear ſuch another Crop immediately after being ſo much exhauſted, and unplowed for a whole Year, except it be extraordinary rich, or much dunged: However, Two Crops of Turnep-ſeed immediately ſucceeding one another, is what I never knew, or heard of, except my own that were Horſe-ho'd; and of theſe the Second Crop was as good as the Firſt; their Stalks grew much higher than they uſually do in the common way; and tho' the Number of Plants was much leſs, their Produce was ſo valuable, that the *Vicar*'s *Agent* declared, he made Twenty-Shillings *per* Acre of his Tythe of a whole Field which he tythed in Kind. The Expence of theſe Crops was judg'd to be anſwered by the Fuel of the threſh'd Stalks. It muſt be noted, that the extraordinary Value of theſe Crops aroſe, not from a greater Quantity of Seed than ſome common Crops; but from their Quality, Experience having brought this Seed into great Eſteem, on account of its being perfectly clean, and produced by large Turneps of a good Sort, and of a proper Shape; for thoſe that are not well cultivated are very apt to degenerate, and then their Seed will produce Turneps of a ſmall Size, and of a long rapy ill Shape.

Improver of the Soil; except it ſhould be ſuch, as might occaſion Trouble, by filling it full of its ſhatter'd Seeds, which might do the Injury of Weeds to the next Crop; and except ſuch Plants, which have a vaſt Bulk to be maintained a long time, as Turnep-ſeed (*a*).

The wider the Intervals are, the more Earth may be divided; for the Row takes up the ſame Room with a wide, or a narrow Interval; and therefore with the wide, the unho'd Part bears a leſs Proportion to the ho'd Part than in the narrow.

And 'tis to no purpoſe to hoe, where there is not Earth to be ho'd, or room to hoe it in.

There are many ways of Hoeing with the Hoe-Plough; but there is not room to turn Two deep clean Furrows in an Interval that is narrower than Four Feet Eight Inches; for if it want much of this Breadth, one, at leaſt, of theſe Furrows, will reach, and fall upon the next Row, which will be very injurious to the Plants; except of grown St. Foin, and ſuch other Plants, that can bear to have the Earth pull'd off them by Harrows.

Thus much of Hoeing in general may ſuffice: And different ſorts of Plants, requiring different Management; that may more properly be deſcribed in the Chapter, where particular Vegetables are treated of.

It may not be amiſs to add, that all ſorts of Land are not equally proper for Hoeing: I take it, that a dry friable Soil is the beſt. Intractable wet Clays, and ſuch Hills that are too ſteep for Cattle to draw a Plough up and down them, are the moſt improper (*b*).

(*a*) Turneps run to Seed, not till the ſecond Summer.

(*b*) For by Hoeing croſs the Hill, the Furrow turn'd againſt the Declivity cannot be thrown up near enough to the Row above it; and the Furrow that is turn'd downwards will bury the Row below it.

That 'tis not ſo beneficial to hoe in Common-fields, is not in reſpect of the Soil, but to the old Principles, which have bound the Owners to unreaſonable Cuſtoms of changing the Species of Corn, and make it neceſſary to fallow every Second, Third, or Fourth Year at fartheſt.

CHAP. VII.

Of WEEDS.

PLANTS, that come up in any Land, of a different Kind from the ſown or planted Crop, are Weeds.

That there are in Nature any ſuch things as *inutiles Herbæ*, the Botaniſts deny; and juſtly too, according to their Meaning.

But the Farmer, who expects to make Profit of his Land from what he ſows or plants in it, finds not only *Herbæ inutiles*, but alſo *noxiæ*, unprofitable and hurtful Weeds; which come like *Muſcæ*, or uninvited Gueſts, that always hurt, and often ſpoil his Crop, by devouring what he has, by his Labour in Dunging and Tilling, provided for its Suſtenance.

All Weeds, as ſuch, are pernicious; but ſome much more than others; ſome do more Injury, and are more eaſily deſtroy'd; ſome do leſs Injury, and are harder to kill; others there are, which have both theſe bad Qualities. The hardeſt to kill are ſuch as will grow and propagate by their Seed, and alſo by every Piece of their Roots, as Couch-graſs, Coltsfoot, Melilot, Fern, and ſuch-like. Some are hurtful only by robbing legitimate (or ſown) Plants of their Nouriſhment, as all Weeds do; others both leſſen a legitimate Crop by robbing it, and alſo ſpoil that Crop, which eſcapes their Rapine, when they infect it with their nauſeous Scent and Reliſh, as Melilot, wild Garlick, *&c.*

Weeds ſtarve the ſown Plants, by robbing them of their Proviſion of Food *(a)*, not of their Room (as ſome Authors vainly imagine); which will appear by the following Experiment.

Let Three Beds of the ſame Soil, equal, and equally prepared, be ſown with the ſame ſort of Corn. Let the Firſt of theſe Beds be kept clean from Weeds: In the Second, let a Quantity of Weeds grow along with the Corn; and in the Third, ſtick up a Quantity of dead Sticks, greater in Bulk than the Weeds.

It will be found, that the Produce of the Corn in the Firſt will not exceed that of the Third Bed; but in the Second, where the Weeds are, the Corn will be diminiſh'd in proportion to the Quantity of Weeds amongſt it.

The Sticks, having done no Injury to the Corn, ſhew there was room enough in the Bed for Company to lodge, would they forbear to eat; or elſe (like Travellers in *Spain)* bring their Proviſion with them to their Inn, or (which would be the ſame thing) if Weeds could find there ſome Diſh ſo diſagreeable to the Palate of the Corn, and agreeable to their own, that they might feed on it without Robbing; and then they would be as innocent as the Sticks, which take up the ſame Room with the Weeds.

The Quantity of Nouriſhment Weeds rob the Corn of, is not in proportion only to their Number and Bulk, but to the Degrees of Heat in their Conſtitution;

(*a*) A Tree of any ſort will ſpoil Corn all round it, in a large Circle; half an Acre of Turneps has been ſpoil'd by one: Hereby 'tis plain, that Trees rob as Weeds; becauſe 'tis not by their Shadow, there being as much Damage done by them on the South-ſide, where their Shadow never comes, as on their North-ſide: Nor can it be by their dropping; for 'tis the ſame on the ſide where a Tree has no Boughs to drop over the Plants, when they are alſo at a very great Diſtance from all Parts of the Tree, except its Roots.

ſtitution; as appears by the Inſtance of Charlock and Turneps, mention'd in the Chapter *Of Change of Species.*

'Tis needleſs to go about to compute the Value of the Damage Weeds do, ſince all experienc'd Huſbandmen know it to be very great, and would unanimouſly agree to extirpate their whole Race as intirely, as in *England* they have done the Wolves, tho' much more innocent, and leſs rapacious, than Weeds *(a).*

But alas! they find it impoſſible to be done, or even to be hoped for, by the common Huſbandry; and the Reaſons I take to be theſe.

The Seeds of moſt ſorts of Weeds are ſo hardy, as to lie ſound and uncorrupt for many Years *(b)*, or perhaps Ages, in the Earth; and are not kill'd until they begin to grow or ſprout, which very few of them do, unleſs the Land be plow'd; and then enough of them will ripen amongſt the ſown Crop, to propagate and continue their Species, by ſhedding their Off-ſpring in the Ground (for 'tis obſerv'd they are generally ripe before the Corn); and the Seeds of theſe do the ſame in the next ſown Crop; and thus perpetuate their ſavage, wicked *(c)* Brood, from Generation to Generation.

Beſides, their Seeds never all come up in one Year, unleſs the Land be very often plow'd; for they muſt have their exact Depth, and Degrees of Moiſture and Heat,

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(*a*) If we conſider the Crops they utterly deſtroy, and thoſe they extremely diminiſh; and that very few Crops eſcape without receiving Injury from them; it may be a Queſtion, whether the Miſchief Weeds do to our Corn, is not as great as the Value of the Rent of all the Arable Lands in *England.*

(*b*) The Seeds of *Lethean Poppy* (call'd *Red-weed*) have lain dormant 24 Years (the Land being, during that time, in *St. Foin*) and then at firſt Plowing they came up very thick; this I have ſeen, and ſo will many other ſorts of Weeds, when the Ground has lain untill'd for an Age.

(*c*) The French call them, *les Herbes Sauvages, & les mechantes Herbes.*

Heat, to make them grow; and ſuch as have not theſe, will lie in the Ground, and retain their vegetative Virtue for Ages; and the common uſual Plowings, not being ſufficient to make them all, or the greateſt Part, grow, almoſt every Crop that ripens increaſes the Stock of Seed, until it make a conſiderable Part of the Staple of ſuch Land as is ſown without good Tillage and Fallowing.

The beſt Defence againſt theſe Enemies, which the Farmer has hitherto found, is to endeavour their Deſtruction by a good Summer-fallow: This indeed, if the Weather be propitious, does make Havock of them; but ſtill ſome will eſcape one Year's Proſecution. Either by being ſometimes ſituate ſo high, that the Sun's Heat dries them, or ſometimes lying ſo deep, that it cannot reach them; either way their Germination, which would have proved their Death, is prevented.

Another Faculty ſecures abundance of them, and that is, their being able to endure the Heat and Moiſture of one Year without growing; as *(a)* wild Oats, and innumerable other ſorts of Weeds, will do; for gather theſe when ripe, ſow them in the richeſt Bed, water them, and do all that is poſſible to make them grow the Firſt Year, it will be vain Labour; they will reſiſt all Enticements till the Second; that is, if you gather them in Autumn, you cannot force them to grow until the next Spring come Twelvemonth; and many of them will remain dormant even to the next Year after that, and ſome of them longer.

By this means, One Year's Summer-fallow can have no effect upon them, but to prepare the Soil for

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(*a*) I have not try'd wild Oats by ſowing them in a Bed myſelf, but have been ſo inform'd by others; and my own Experience hath frequently ſhewn me, that they will come up, after lying many Years in the Ground; and that very few ſorts of Weeds will come all up the firſt Year, as Corn doth: If they did, the Tillage of one Year's Summer-fallow might extirpate them.

for their more vigorous Growth, and plentiful Increaſe the next Year after; and very rarely will the Farmer fallow his Land Two Years ſucceſſively; and often the Dung, which is made of the Straw of ſown Corn, being full of the Seeds of Weeds, when ſpread on the Fallows, incumbers the Soil with another Stock of Weeds, as ample as that the Fallowing has deſtroy'd; and tho' perhaps many of theſe may not grow the next Year, they will be ſure to come up afterwards.

The other old Remedy is what often proves worſe than the Diſeaſe; that is, what they call Weeding among ſown Corn; fot if by the Hook or Hand they cut ſome ſorts (as Thiſtles) while they are young, they will ſprout up again, like *Hydras*, with more Heads than before; and if they are cut when full-grown, after they have done almoſt their utmoſt in robbing the Crop, 'tis like ſhutting the Stable-door after the Steed is ſtollen.

Hand-weeders often do more Harm to the Corn with their Feet, than they do Good by cutting or pulling out the Weeds with their Hands; and yet I have known this Operation ſometimes coſt the Farmer Twelve Shillings an Acre; beſides the Damage done by treading down his Wheat; and, after all, a ſufficient Quantity of them have eſcaped, to make a too plentiful Increaſe in the next Crop of Corn.

The new Hoeing-Huſbandry in time will probably make ſuch an utter Riddance *(a)* of all ſorts of Weeds *(b)*, except ſuch as come in the Air, that

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(*a*) A very pernicious, large, perennial Weed, like *Burrage*, with a blue Flower, infeſted a Piece of Land, for time out of mind: Hoeing has deſtroyed it utterly; not one of the Species has been ſeen in the Field theſe Seven Years, tho' conſtantly till'd and ho'd.

(*b*) I have now a Piece of Wheat drill'd early the laſt Autumn upon an Hill, fallowed and well pulveri z'd: Part of it was drill'd with Wheat in double Rows upon the Level Nine Years ago, Horerthat (c) as long as this Management is properly continued, there is no Danger to be apprehended from them; which is enough to confute the old Error

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Horſe-ho'd, and the Partitions thoroughly Hand-ho'd to cleanſe out the Poppies, of which the Land was very full; the other Part of this Piece was never drilled till this Year: The whole Piece hath not been before this Winter Horſe-ho'd. Now the Partitions of the Part that was never any way Ho'd, are ſo ſtock'd with Poppies matted together, that unleſs they are taken out early in the Spring, they will totally devour the Rows of Wheat; but in the other Part that was ho'd ſo long ſince, there are now very few Poppies to be ſeen. Both theſe Parts have had ſeveral ſown Crops of Barley together ſince, and have lain with *St. Foin*, theſe laſt Five or Six Years.

(c) And except alſo ſuch Weeds, whoſe Seed is carried by Birds, which is the moſt common Manner of tranſporting the Seeds of Vegetables from Field to Field, againſt the Conſent of the Owner: For Birds, whether great or ſmall, do not care to eat their Prey where they take it, but generally chuſe ſome open Place for that Purpoſe. 'Tis, I am perſuaded, by this means chiefly, that a Vineyard or Field, made ever ſo clean from Graſs, will, in lying untilled a few Years, be repleniſhed with a Turf of that neighbouring Species of Graſs, which beſt ſuits the Heat and Moiſture of the Soil: Yet there are ſome Species of Seeds that Birds (at leaſt ſuch as frequent this Place) do not affect; elſe the Burrage-weed (mentioned in *p.* 77.) would have appeared again in my Field in ſome of the many Years ſince the Hoeing has extirpated it there; for it grows plentifully in the unplowed Way adjoining thereto.

The Seeds of ſome Weeds may be ſuſpected to come in the Air; as the Seed of the Graſs that grew in *Cheapſide*, in the time of the Plague; but it might come from Seeds in the Dirt, brought thither by the Feet of People and Cattle, and by the Wheels of Coaches, Carts carrying Hay: Or otherwiſe continual Treading might keep it from Growing; and when the Treading ceaſed, 'tis no wonder the Seeds ſhould furniſh the Streets with Graſs.

And I have obſerv'd on the Floors, Two Stories high, of a lone, ruinous, uninhabited Houſe, being long uncover'd, a ſort of Herb growing very thick; I think it was *Pimpernel*, and believe that its Seeds did not come thither in the Air; but in the Sand which was mix'd with the Morter that had fallen from the Cielings; and 'tis like there were few Seeds at firſt: Yet, theſe, ripening for ſeveral Years, ſhed their Seeds annually, until the Floors became all over very thick planted: Beſides, Hay-ſeeds and Pimpernel are too heavy to be carry'd far by the Air.

of equivocal Generation, had it not been already ſufficiently exploded, ever ſince that Demonſtration of *Malpighius*'s Experiment. For if Weeds were brought forth without their proper Seeds, the Hoeing could not hinder their Production, where the Soil was inclined naturally to produce them. The Belief of that blind Doctrine might probably be one of the Cauſes, that made the Antients deſpair of finding ſo great Succeſs in Hoeing, as now appears; or elſe, if they had had true Principles, they might perhaps have invented and improved that Huſbandry, and the Inſtruments neceſſary to put it in Practice.

CHAP. VIII.

Of TURNEPS.

AS far as I can be inform'd, 'tis but of late Years that Turneps have been introduc'd as an Improvement in the Field.

All Sorts of Land, when made fine by Tillage, or by Manure and Tillage, will ſerve to produce Turneps, but not equally; for chalky Land is generally too dry (a Turnep being a thirſty Plant); and they are ſo long in ſuch dry poor Land before they get into rough Leaf, that the Fly is very apt to deſtroy them there; yet I have known them ſucceed on ſuch Land, tho' rarely.

Sand and Gravel are the moſt proper Soil for Turneps, becauſe that is moſt eaſily pulveriz'd, and its Warmth cauſeth the Turneps to grow faſter, and ſo they get the ſooner out of the Danger of the Fly; and ſuch a Soil, when well till'd, and Horſe-ho'd, never wants a ſufficient Moiſture, even in the drieſt Weather; and the Turneps being drill'd will come up without Rain, and proſper very well with the ſole

Moiſture of the Dews, which are admitted as deep as the Pulveration reacheth; and if that be to Five or Six Inches, the hotteſt Sun cannot exhale the Dews thence in the Climate of *England:* I have known Turneps thrive well in a very dry Summer by repeated Horſe-hoeings, both in Sand, and in Land which is neither ſandy nor gravelly.

When I ſow'd Turneps by Hand, and ho'd them with a Hand-hoe, the Expence was great, and the Operation not half perform'd, by the Deceitfulneſs of the Hoers, who left half the Land unho'd, and cover'd it with the Earth from the Part they did hoe, and then the Graſs and Weeds grew the faſter: Beſides, in this manner a great Quantity of Land could not be managed in the proper Seaſon.

When I drill'd upon the Level (*a*), at Three Feet Intervals, a Trial was made between thoſe Turneps and a Field of the next Neighbour's, ſown at the ſame time, whereof the Hand-hoeing coſt Ten Shillings *per* Acre, and had not quite half the Crop of the drill'd, both being meaſur'd by the Buſhel, on purpoſe to find the Difference (*b*).

In the new Method they are more certain to come up quickly; becauſe in every Row, half the Seed is planted about Four Inches deep (*c*); and the other Half is planted exactly over that, at the Depth of half an Inch, falling in after the Earth has cover'd

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(*a*) 'Tis impoſſible to hoe-plow them ſo well when planted upon the Level, as when they are planted upon Ridges; for if we plow deep near the Row, the Earth will come over on the Left-ſide of the Plough, and bury the younger Turneps; but when they ſtand on Ridges, the Earth will almoſt all fall down on the Right Side into the Furrow in the Middle of the Interval.

(*b*) And I have ſince found, that Turneps on the ſame Land, planted on Ridges, with Six-feet Intervals, make a Crop double to thoſe that are planted on the Level, or even on Ridges with Three-feet Intervals.

(*c*) Turnep-ſeed will come up from a greater Depth than moſt other Sorts of Seeds.

the firſt Half: Thus planted, let the Weather be never ſo dry, the deepeſt Seed will come up; but if it raineth (immediately after planting), the ſhallow will come up firſt: We alſo make it come up at Four *(d)* times, by mixing our Seed, half new and half old (the new coming a Day quicker than the old): Theſe four Comings up give it ſo many Chances for eſcaping the Fly, it being often ſeen, that the Seed ſown over Night will be deſtroy'd by the Fly, when that ſown the next Morning will eſcape, and *vice verſa* (*e*); or you may hoe-plow them, when you ſee the Fly is like to devour them; this will bury the greateſt Part of thoſe Enemies; or elſe you may drill in another Row, without new plowing the Land.

This Method has alſo another Advantage of eſcaping the Fly, the moſt certain of any other, and infallible, if the Land be made fine, as it ought to be: This is to roll it with a heavy Roller acroſs the Ridges, after 'tis drill'd, which, cloſing up the Cavities of the Earth, prevents the Fly's Entrance and Exit, to lay the Eggs, hatch, or bring forth the young ones to prey upon the Turneps; which they might intirely devour, if the Fly came before they had more than the firſt two Leaves, which, being form'd of the very Seed itſelf, are very ſweet; but the next Leaves are rough and bitter, which the Fly does not love: I have always found the Rolling diſappoint the Fly; but very often it diſappoints the Owner alſo, who ſows at random; for it makes the Ground ſo hard, that the Turneps cannot thrive, but look yellow, dwindle, and grow to no Perfection, unleſs they have a good Hoeing ſoon after the rough Leaves appear; for

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(*d*) I have ſeen drill'd Turnep-ſeed come up daily for a Fortnight together, when it has not been mixt thus, the old with the new.

(*e*) I have had the firſt Turneps that came up all deſtroy'd by the Fly; and about a Fortnight afterwards more have come up, and been ho'd time enough, and made a good Crop.

when they ſtand long without it, they will be ſo poor and ſtinted, that the Hand-hoe does not go deep enough to recover them; and 'tis ſeldom that theſe rolled Turneps can be Hand-ho'd at the critical Time, becauſe the Earth is then become ſo hard, that the Hoe cannot enter it without great Difficulty, unleſs it be very moiſt; and very often the Rain does not come to ſoak it, until it be too late; but the drill'd Turneps being in ſingle Rows with Six-feet Intervals, may be roll'd without Danger: For be the Ground ever ſo hard, the Hand-hoe will eaſily ſingle them out, at the Price of Six-pence per Acre, or leſs (if not in Harveſt); and the Horſe-hoe will, in thoſe wide Intervals, plow at any time, wet or dry; and, tho' the Turneps ſhould have been neglected till ſtinted, will go deep enough to recover them to a flouriſhing Condition.

Drill'd Turneps, by being no-where but in the Rows *(f)*, may be more eaſily ſeen than thoſe which come up at random; and may therefore be ſooner *(g)* ſingled

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(*f*) Drill'd Turneps coming all up nearly in a *Mathematical Line*, 'tis very rarely that a Charlock, or other like Weed, comes up in the ſame Line amongſt them, unleſs it be drilled in with the Turnep-ſeed, of which Weeds our Horſe-ho'd Seed never has any; there being no Charlock in the Rows, nor any Turnep in the Intervals: We know, that whatever comes up in the Interval is not a Turnep, though ſo like to it, that, at firſt coming up, if promiſcuouſly, it cannot eaſily be diſtinguiſhed by the Eye, until after the Turneps, *&c.* attain the rough Leaf; and even then, before they are of a conſiderable Bigneſs, they are ſo hard to be diſtinguiſhed by thoſe People, who are not well experienced, that a Company of *Hand-hoers* cut out the Turneps by Miſtake, and left the Charlock for a Crop of a large Field of ſown Turneps. Such a Misfortune can never happen to drilled Turneps, unleſs wilfully done, be they ſet out ever ſo young.

(*g*) The ſooner they are made ſingle, the better; but yet, when they are not very thick, they may ſtand till we have the beſt Convenience of ſingling them without much Damage; but, when they come up extraordinary thick, 'twill be much more difficult to make them ſingle, if they are neglected at their very firſt coming into rough Leaf.

ſingled out by the Hand-hoe; which is another Advantage; becauſe the ſooner they are ſo ſet out, the better they will thrive (*h*).

Three or Four Ounces of Seed is the uſual Quantity to drill; but, at random, Three or Four Pounds are commonly ſown, which, coming thick all over the Ground, muſt exhauſt the Land more than the other, eſpecially ſince the ſown muſt ſtand longer, before the Hoers can ſee to ſet them out.

The Six-feet Ridges, whereon Turneps are drill'd in ſingle Rows, may be left higher than for double-row'd Crops; becauſe there will be more Earth in the Intervals, as the ſingle Row takes up leſs.

There is no prefix'd Time for planting Turneps, becauſe that muſt be according to the Richneſs of the Land; for ſome Land will bring them as forward, and make them as good, when planted the Beginning of *Auguſt*, as other Land will, when planted in *May*; but the moſt general Time is, a little before, and a little after *Midſummer*.

Between theſe Rows of Turneps (*i*), I have planted Wheat in this manner; *viz.* About *Michaelmas*, the Turneps

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(*h*) Becauſe ſuch young Turneps will enjoy the more of the Paſture made by the Plowing, and by that little Pulveration of the Hand-hoe, without being robb'd of any Paſture by their own ſupernumerary Plants.

(*i*) As I have formerly drilled Wheat between Rows of Turneps, ſo I have ſince had the Experience of drilling Turneps between Rows of Barley and Rows of Oats: I have had them in the Intervals between Six-feet Ridges, and between Four-feet Ridges, and between thoſe of ſeveral intermediate Diſtances; but which of them all is the beſt, I leave at preſent undetermined. I ſhall only add, that the poorer the Land is, the wider the Intervals ought to be; and that, in the narrow, 'tis convenient at the Hoeing, to leave more Earth on that Side of each Interval whereon the Turneps are to be drill'd; and this is done by going round ſeveral Intervals with the Hoe-plough, without going forwards and backwards in each immediately: But in the wide Intervals the Earth may be equal on both Sides of them.

Turneps being full grown, I plow'd a Ridge in the Middle of each of their Intervals, taking moſt of the

Earth

I will propoſe another Method of Drilling, which may be very advantageous to thoſe who ſow their Barley upon the Level, and ſow Turnep-ſeed amongſt it, at random, as they do Clover; which is, of late, a common Practice in ſome Places. The Barley keeps the Turneps under it, and ſtints them ſo much, that they are uſeful in the Winter or Spring, chiefly by the Food their *Leaves* afford to Sheep, their Roots being exceeding ſmall; and for this ſmall Profit they loſe the Time of tilling the Ground, until after the Turneps are eaten off; which is a Damage we think greater than the Profit of ſuch Turneps: To prevent which Damage, they may drill them in Rows at competent Diſtances, and Horſe-hoe them, and ſet them out as ſoon as the Barley is off: This will both keep the Ground in Tilth, fit for another Crop of Spring Corn, and cauſe the Turneps to grow great enough (eſpecially if Harveſt be early, and the Winter prove favourable) for feeding of Sheep in a moveable Fold to dung the Ground into the Bargain.

What induces me to propoſe this Improvement is, that a Gentleman plows up his Barley-Stubble, and tranſplants Turneps therein, and Hand-hoes them with Succeſs. By the propoſed Way all the Expence of tranſplanting (which muſt be conſiderable) will be ſaved; and the ſetting out cannot be more than an Eighth of the Labour of *Hand-hoeings*; and I conjecture the Horſe-hoed Turneps may be as good; for they (though ſtinted) having their Tap-roots remaining unmoved below the Staple of the Land, their horizontal Roots, being ſupply'd with Moiſture from the Tap-roots, immediately take hold of the freſh-plowed Earth, as ſoon as 'tis turned back to them; whereas the tranſplanted, having their Tap-roots broken off, and their Horizontal Roots crumpled in the Holes wherein they are ſet, muſt loſe Time, and be in Danger of dying with Thirſt, if the Weather proves dry.

Alſo this Way ſeems better than the common Practice of ſowing Turneps upon once plowing after Wheat; becauſe the Wheat-land commonly lies longer unplow'd by Six or Eight Months than Barley-land; and therefore cannot be in ſo good Tilth for Turneps as Barley-land may, unleſs the former be of a more friable Nature, or much more dunged, than the latter. Beſides, theſe Wheat-Turneps are uncertain, in reſpect of the Fly that often deſtroys them at their firſt coming up; which Misfortune happened the Autumn 1734. to almoſt all that were ſown in that Manner.

I have obſerv'd, that Barley ſown on the Level, and not hoed, overcomes the Turneps that come up amongſt it; but that Tur-

neps

Earth from the Turneps, leaving only juſt enough to keep them alive; and on this Ridge drill'd my Crop of Wheat (*k*), and towards the Spring pull'd up my Turneps, and carried them off for Cattle.

When Turneps are planted too late, to have Time and Sun for attaining to their full Bulk, ſome drill a double Row on each Six-feet Ridge, with a Partition of Fourteen Inches; but I am told, that in this double Row the Turneps do not, even at that late Seaſon, grow ſo large, as thoſe planted at the ſame time in ſingle Rows; tho' the double Row requires

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neps which come up in the Partitions of Treble Rows of my Ridges of Horſe-hoed Barley, grew ſo vigorouſly as to overcome the Barley. And this was demonſtrated at Harveſt in a long Field, one Side of which had borne Turnep-ſeed, and the drilled Ridges of Barley croſſing the Middle of it; and both Ends of the Field having Barley ſown on the Level, one End of every Ridge croſs'd the Turnep-ſeed Part of the Field for about Ten Perches of their Length.

I obſerved alſo, that the Turneps near the Edges of the Lands of ſown Barley, adjoining to the hoed Intervals, grew large, but not ſo large as thoſe in the Partitions on the Ridges, their Intervals being hoed on each Side of them.

But different from this have I ſeen ſhattered Turnep-ſeed coming up in the like Partitions of drilled Wheat, on the very ſame Sort of Land, ſo miſerably poor and ſtinted, that they ſcarce grew a Hand's-breadth high, when thoſe Turneps which the Hoe left in the Sides of the Intervals, and at the narrow Edges of the unhoed Earth of the Interval Sides of the Rows of Wheat, grew large; and the Wheat was good alſo: But I do not remember how the middle Row of it ſucceeded.

This laſt Experience of the Turneps among the Wheat was got by this Accident: The Wheat was drilled after drilled Turneps on Ridges of a different Size. The Turneps were all pulled up before the Ground was plowed for the Wheat; but as Turnep-ſeed never comes *all* up the firſt Year, enough remained of this to come up (though thinly) in the Wheat, to ſhew exactly where every Row had been drilled; whereupon the Obſervation was made.

(*k*) This Wheat, being thus drill'd on the new Ridges made in the Intervals, betwixt the Rows of Turneps, being well Horſe-ho'd in the Spring, prov'd a very good Crop; it was drill'd in treble Rows, the Partitions Seven Inches each.

double the Expence in ſetting out; and there will be leſs Earth ho'd by the Breadth of Fourteen Inches of the deepeſt Part of the Ridge; and conſequently the Land will be the leſs improv'd for the next Crop. We need not to be very exact, in the Number *(l)* or Diſtance *(m)* we ſet them out at; we contrive to leave the Maſter-turneps (when there is much Difference in them), and ſpare ſuch when near one another, and leave the more Space before and behind them; but if they be Three Maſter-turneps too near together, we take out the middlemoſt.

Turneps that were ſo thick as to touch one another when half-grown, by means of well Hoeing their wide Intervals, have afterwards grown to a good Bigneſs, and by thruſting againſt one another became oval, inſtead of round.

'Tis beneficial to hoe Turneps (eſpecially the firſt time) alternately; *viz.* to hoe every other Interval, and throw the Earth back again before we hoe the other Intervals; for by this means the Turneps are kept from being (*n*) ſtinted: 'Tis better to have Nouriſhment given them moderately at twice, than to have it all at once, and be twice as long before a Repetition (*o*).

(l) The leaſt Number will be the largeſt Turneps; yet we ſhould have a competent Stock, which I think is not leſs than Thirty on a ſquare Perch.

(*m*) The Diſtance need not to be regular; for when a Turnep has Six Inches of Room on one Side, and Eighteen Inches on the other Side, 'tis almoſt as well as if there was one Foot on each Side; tho' then it would be equally diſtant from the Two Turneps betwixt which it ſtood.

(*n*) Becauſe this alternate Hoeing doth not at all endanger the Roots by being dried by the Sun; for whilſt one Half of the Roots have Moiſture, 'tis ſufficient; the other Half will be ſupplied from thoſe; ſo that they will ſoon take hold of the Earth again after being moved by the Hoe.

(*o*) Sometimes, when Turneps are planted late, this alternate Hoeing ſuffices without any Repetition; but when they are planted early, 'twill be neceſſary to hoe them again; eſpecially if Weeds appear.

Tho' the Earth on each Side the Row be left as narrow as poſſible (*p*); yet 'tis very profitable to hoe that little with a *Bidens* (*q*), called here a Prong-hoe (*r*); for this will be ſure to let out all the Roots into the Intervals, even ſuch as run very nearly parallel to the Rows.

This alternate Way of Hoeing Plants that grow in ſingle Rows, is of ſuch vaſt Advantage, that Four of theſe, which are but equal to Two of the *whole* Hoeings in Labour, are near equal to Four *whole* Hoeings in Benefit; for when one Side is well nouriſhed, the other Side cannot be ſtarv'd (*s*).

Beſides, where a great Quantity of Turneps are to be ho'd, the laſt ho'd may be ſtinted, before the firſt are finiſh'd by *whole* Hoeings.

In this alternate Hoeing, the Hoe-plough may go deeper (*t*) and nearer to the Row, without Danger of thruſting it down on the Left Side, whilſt the Plants are very ſmall; becauſe the Earth on the other Side of the Row always bears againſt it for its Support: But in the *whole* Hoeing, there is an open Furrow left the Firſt time on both Sides of the Row, and there is Danger of throwing it into one Furrow in

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(*p*) I do not think that we can go nearer to the Plants with the Hoe-plough, than within Three Inches of their Bodies.

(*q*) We ought not to uſe the *Bidens* for this Purpoſe, before the perpendicular Roots are as big as one's little Finger.

(*r*) Some of theſe Prong-hoes have Three Teeth, and are reckoned better as a *Tridens* than a *Bidens*; but this is only in mellow Ground.

(*s*) But yet ſometimes the Weeds, or other Circumſtances, may make it proper to give them a *whole* Hoeing at firſt.

(*t*) This deep Plowing ſo near to the Row is very beneficial at firſt; but afterwards, when the Plants are grown large, and have ſent their Roots far into the Intervals, it would almoſt totally diſroot them; and they, being Annuals, might not live long enough for a new Stock of Roots to extend ſo far as is neceſſary to bring the Turneps to their full Bigneſs.

Note, At the laſt Hoeing we generally leave a broad, deep Trench in the Middle of each Interval.

plowing the other; or, if the Row is not thrown down, it may be too much dry'd in hot Weather, by the Two Furrows lying too long open: Yet, when the Turneps are large before Hoeing, we need not fear either of theſe Dangers in giving them a *whole* Hoeing; as I have found by Experience, even when there has been left on each Side of the Row only about Three Inches Breadth of Earth; tho' it is not beſt to ſuffer it to lie long open (*u*).

Dry Weather does not injure Turneps when Horſe-ho'd, as it does ſown Turneps; the Hand-hoe does not go deep enough to keep the Earth moiſt, and ſecure the Plants againſt the Drought; and that is the beſt Seaſon for Horſe-hoeing, which always can keep the Roots moiſt (*x*).

Dung and Tillage together will attain the neceſſary Degree of Pulveration, in leſs time than Plowing can do alone: Therefore Dung is more uſeful for Turneps, becauſe they have commonly leſs time to grow than other Plants.

Turneps of Nineteen Pounds Weight I have ſeveral times heard of, and of Sixteen Pounds Weight often known; and Twelve Pounds may be reckon'd the middle Size of great Turneps: And I can ſee no Reaſon, why every Turnep ſhould not arrive to the full Bigneſs of its Species, if it did not want Part of its due Nouriſhment.

(*u*) But, if the Weather prove wet, we always ſuffer thoſe Furrows to lie open, until the Earth be dry enough to be turn'd back again to the Row, without ſmearing or ſticking together; unleſs ſuch Weather continue ſo long that the Weeds begin to come up, and then we throw back the Furrows to ſtifle the Weeds, before they grow large, tho' the Earth be wet.

(*x*) But if ſome Sorts of Earth have lain ſo long unmoved as to become very hard before the firſt Hoeing, the Hoe, going very near to the Rows on each Side, may cauſe ſuch hard Earth whereon the Rows ſtand, to crack and open enough to let in the Drought (*i. e.* the Sun and Air) to the Roots in very dry Weather. In this Caſe 'tis beſt to *Horſe-hoe* alternately, as is directed in *Page* 86.

The greateſt Inconvenience, which has been obſerv'd in the Turnep huſbandry, is, when they are fed off late in the Spring (which is in many Places the greateſt Uſe of them), there is not time to bring the Land in Tilth for Barley; the Loſs of which Crop is ſometimes more than the Gain of the Turneps: This is intirely remedied by the drilling Method; for, by that, the Land may be almoſt as well till'd before the Turneps are eaten, or taken off, as it can afterwards.

If Turneps be ſown in *June*, or the Beginning of *July*, the moſt experienced Turnep-farmers will have no more than Thirty to a ſquare Perch left in Hand-hoeing; and find that when more are left, the Crop will be leſs; but, in drilling the Rows at Six Feet Intervals, there may be Sixty to a Perch; and the Horſe-hoe, by breaking ſo much more Earth than the Hand-hoe does, can nouriſh Sixty drill'd, as well as Thirty are by the ſowing Method, which has been made appear upon Trial; but, I think, about Forty or Forty-five better than Sixty on a Perch; and the Number of Plants ſhould always be proportion'd to the natural and artificial Paſture which is to maintain them; and Sixty Turneps on a ſquare Perch, at Five Pounds each (which is but a Third of the Weight of the large Size of Sheep-turneps), make a Crop of above Eighty Quarters to an Acre (*y*).

When

(*y*) I have had Turneps upon poor undung'd Land, that weigh'd Fourteen Pounds apiece; but theſe were only ſuch as had more Room than the reſt. I have ſeen a whole Waggon-load of drill'd Turneps ſpread on the Ground, wherein I believe one could not have found one that weighed ſo little as Six Pounds; or if the Rows had been ſearched before they had been pull'd up, they would have weighed Seven or Eight Pounds apiece one with another; we weighed ſome of them that were Thirteen, ſome Fourteen Pounds each, and yet they ſtood pretty thick: There might be, as I gueſs, about Fifty on a ſquare Perch; but this Crop was on ſandy Land, not poor; and was dung'd the Third

or

When Turneps are planted late (eſpecially upon poor Ground), they may be a greater Number than when planted early; becauſe they will not have time enough of Heat to enjoy the full Benefit of Hoeing, which would otherwiſe cauſe them to grow larger.

The greateſt Turnep-Improvement uſed by the Farmer, is for his Cattle in the Winter; one Acre of Turneps will then maintain more than Fifty of Meadow or Paſture-ground.

'Tis now ſo well known, that moſt Cattle will eat them, and how much they breed Milk, *&c.* that I need ſay nothing about it.

Sheep always refuſe them at firſt, and, unleſs they have eaten them whilſt they were Lambs, muſt be ready to ſtarve before they will feed on them; tho', when they have taſted them, they will be fatted by them; and I have ſeen Lambs of Three Weeks old ſcoop them prettily, when thoſe of a Year old (which are call'd Tegs) have been ready to die with Hunger amongſt them; and for Three or Four Days would not touch them, but at laſt eat them very well.

In ſome Places, the greateſt Uſe of Turneps (except for fatting Oxen and Sheep) is for Ewes and Lambs in the Spring, when natural Graſs is not grown on poor Ground; and if the artificial Graſs be then fed by the common manner, the Crop will be ſpoil'd, and it will yield the leſs Paſture all the Summer: I have known Farmers, for that Reaſon, oblig'd to keep their Ewes and Lambs upon Turneps (tho' run up to Seed) even until the Middle of *April*.

There are now three manners of ſpending Turneps with Sheep, amongſt which I do not reckon the Way of putting a Flock of Sheep into a large Ground of Turneps without dividing it; for in that Caſe the

or Fourth Year before; and had every Year a ho'd Crop of Potatoes, or Wheat, until the Year wherein the Turneps were planted.

Flock will deſtroy as many Turneps in a Fortnight, as would keep them well a whole Winter.

The Firſt manner now in Uſe is, to divide the Ground of Turneps by Hurdles, giving them leave to come upon no more at a time than they can eat in one Day, and ſo advance the Hurdles farther into the Ground daily, until all be ſpent; but we muſt obſerve, that they never eat them clean this way, but leave the Bottoms and Outſides of the Turneps they have ſcoop'd in the Ground. Theſe Bottoms People pull up with Iron Crooks, made for that Purpoſe; but their Cavities being tainted with Urine, Dung, and Dirt from their Feet, tho' the Sheep do eat ſome of the Pieces, they waſte more, and many the Crooks leave behind in the Earth; and even what they do eat of this tainted Food, can't nouriſh them ſo well as that which is freſh and cleanly.

The Second manner is, to move the Hurdles every Day, as in the Firſt; but that the Sheep may not tread upon the Turneps, they pull them up firſt, and then advance the Hurdles as far daily as the Turneps are pull'd up, and no farther: By this means there is not that Waſte made as is in the other Way; the Food is eaten freſh and clean; and the Turneps are pull'd up with leſs Labour than their Pieces can be (z).

The Third manner is, to pull them up, and to carry them into ſome other Ground in a Cart, or Waggon, and there ſpread them every Day on a new

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(z) I have ſeen Three Labourers work every Day with their Crooks, to pull up theſe Pieces, which was done with much Difficulty, the Ground being trodden very hard by the Sheep; when one Perſon, in Two Hours time, would have pull'd up all the *whole* Turneps daily, and the Sheep would have eaten them clean; but ſo many of thoſe Pieces were dry'd and ſpoil'd, that, after the Land was ſown with Barley, they appear'd very thick upon the Surface, and there could not be much leſs than Half the Crop of Turneps waſted, notwithſtanding the Contrivance of theſe Crooks.

Place, where the Sheep will eat them up clean, both Leaf and Root: This is done when there is Land not far off, which has more Need of Dung, than that where the Turneps grow, which perhaps is alſo too wet for Sheep in the Winter; and then the Turneps will, by the too great Moiſture and Dirt of the Soil, ſpoil the Sheep, and in ſome Soils give them the Rot; yet ſuch Ground will bring forth more and larger Turneps than dry Land; and when they are carry'd off, and eaten on plow'd Ground in dry Weather, and on Green-ſwerd in wet Weather, the Sheep will thrive much better; and that moiſt Soil, not being trodden by the Sheep, will be in much the better Order for a Crop of Corn. And generally the Expence of Hurdles, and removing them, being ſaved, will more than countervail the Labour of carrying off the Turneps.

Theſe Three Ways of ſpending Turneps with Sheep are common to thoſe drill'd, and to thoſe ſown in the random manner; but they muſt always be carry'd off for Cows and Oxen; both which will be well fatted by them, and ſome Hay in the Winter: The Management of theſe is the Buſineſs of a Grazier.

CHAP. IX.

Of WHEAT.

THO' all ſorts of Vegetables may have great Benefit from the Hoe, becauſe it ſupplies them with Plenty of Food, at the time of their greateſt need, yet they do not all equally require Hoeing; but the Plant that is to live the longeſt, ſhould have the largeſt Stock of Suſtenance provided for it: Generally Wheat lives, or ought to live, longer than other ſorts of Corn; for if it be not ſown before Spring, its Grain will be thin, and have but little Flour in it, which is the only uſeful Part for making Bread. And when ſown late in the Winter, 'tis in great Danger of Death from the Froſt, whilſt weak and tender, being maintain'd (as a *Fœtus)* by the umbilical Veſſels, until the Warmth of the Sun enables it to ſend out ſufficient Roots of its own to ſubſiſt on, without Help of the *Ovum*.

To prevent theſe Inconveniencies, Wheat is uſually ſown in Autumn: Hence, having about thrice the Time to be maintain'd that Spring Corn hath, it requires a larger Supply of Nouriſhment, in proportion to that longer Time; not becauſe the Wheat in its Infancy conſumes the Stock of Food, during the Winter, proportionably to what it does afterwards; but becauſe, during that long Interval betwixt Autumn and Spring Seed-times, moſt of the artificial Paſture is naturally loſt, both in light and in ſtrong Land.

For this very Reaſon is that extraordinary Pains of fallowing and dunging the Soil, neceſſary to Wheat; tho', notwithſtanding all that Labour and Expence, the Ground is generally grown ſo ſtale by the Spring, and ſo little of the Benefit of that chargeable Culture remains, that, if Part of the ſame Field be ſown in the Beginning of *April*, upon freſh Plowing, without the Dung, or Year's Fallow, it will be as great or a greater Crop, in all reſpects, except the Flour, which fails only for want of Time to fill the Grain.

Poor light Land, by the common Huſbandry, muſt be very well cultivated and manur'd, to maintain Wheat for a whole Year, which is the uſual Time it grows thereon; and if it be ſown late, the greateſt Part of it will ſeldom ſurvive the Winter, on ſuch Land; and if it be ſown very early on ſtrong Land, tho' rich, well till'd and dung'd, the Crop will be worſe than on the poor light Land ſown early. So much do the long Winter's Rains cauſe the Earth to ſubſide, and the divided Parts to coaleſce, and lock out the Roots from the Stock of Proviſion, which, tho' it was laid in abundantly at Autumn, the Wheat has no great occaſion of, until the Spring; and then the Soil is become too hard for the Roots to penetrate; and therefore muſt ſtarve (like *Tantalus*) amidſt Dainties, which may tempt the Roots, but cannot be attain'd by them.

But the new Method of Hoeing gives, to ſtrong and to light Land, all the Advantages, and takes away all the Diſadvantages, of both; as appears in the Chapters of *Tillage* and *Hoeing*. By this Method the ſtrong Land may be planted with Wheat as early as the light (if plow'd dry); and the Hoe-Plough can, if rightly apply'd, raiſe a Paſture to it *(a)*, equal to that of Dung in both ſorts of Land.

About the Year 1701. when I had contrived my Drill for planting St. Foin, I made uſe of it alſo for Wheat. Drilling many Rows at once, which made the Work much more compendious, and perform'd it much better than Hands could do, making the Chanels of a Foot Diſtance, drilling in the Seed, and covering it, did not in all amount to more than Sixpence *per* Acre Expence, which was above Ten times over-paid by the Seed that was ſaved; for One Buſhel to an Acre was the Quantity drill'd; there remain'd then no need of Hand-work, but for the Hoeing; and this did coſt from Half a Crown to Four Shillings per Acre. This way turn'd to a very good Account, and in conſiderable Quantities; it has brought as good a Crop of Wheat on Barley-ſtubble, as that ſown the common Way on Summer-fallow;

(*a*) Becauſe the Hoe may go in it all the Year, and the Soil being *infinitely diviſible*, the Diviſion which the Hoe may make whilſt the Crop is growing, added to the common Tillage, may equal, or even exceed, a common Dreſſing with Dung, as I have often experienced.

and when that ſown the old Way, on the ſame Field, on Barley-ſtubble, intirely fail'd, tho' there was no other Difference but the Drilling and Hoeing: It was alſo ſuch an Improvement to the Land, that when one Part of a ſtrong whitiſh Ground, all of equal Goodneſs, and equally fallow'd and till'd, was dung'd and ſown in the common manner, and the other Part was thus drill'd and hand-ho'd without Dung, the ho'd Part was not only the beſt Crop, but the whole Piece being fallow'd the next Year, and ſown all alike by a Tenant, the ho'd Part produc'd ſo much a better Crop of Wheat than the dung'd Part, that a Stranger would have believ'd by looking on it, that that Part had been dung'd which was not *(a)*, and that Part not to have been dung'd which really was.

Scarce any Land is ſo unfit, and ill prepar'd, for Wheat, as that where the natural Graſs *(b)* abounds. Moſt other ſorts of Weeds may be dealt withal when they come among drill'd Wheat; but 'tis impoſſible to extract Graſs from the Rows: Therefore let that be kill'd before the Wheat be planted.

The Six-feet Ridges being Eleven, on Sixty-ſix Feet, which is an Acre's Breadth, ought to be made Lengthways of the Field, if there be no Impediment againſt it; as if it be an Hill of any conſiderable Steepneſs, then they muſt be made to run up and down, whether that be the Length or Breadth of the Piece; for if the Ridges ſhould go croſs ſuch a Hill, they could not be well Horſe-ho'd; becauſe it would be very difficult to turn a Furrow upwards, cloſe to the Row above it, or to turn a Furrow downwards, without burying the Row below it; and even

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(*a*) If the Dung did pulverize as much as the Hoeing, the Cauſe muſt be from the different Exhauſtion.

(*b*) One Bunch of natural Graſs, tranſplanted by the Plough into a treble Row of Wheat, will deſtroy almoſt a whole Yard of it.

when a Furrow is turn'd from the lower Row, enough of the Earth to bury that Row will be apt to run over on the Left-ſide of the Plough; unleſs it goes at ſuch a Diſtance from the Row, as to give it no Benefit of Hoeing.

Theſe Ridges ſhould be made ſtrait and equal: And to make them ſtrait (*c*) all good Ploughmen know how; and they will, by ſetting up Marks to look at, plow in a Line like the Path of an Arrow: But to make the Ridges equal, 'tis neceſſary to mark out a Number of them, before you begin to plow, by ſhort Sticks ſet up at each End of the Piece; and then if one Ridge happen to be a little too broad, the next may be made the narrower; for if the Plough comes not out exactly at the ſecond Stick, the Two Ridges may be made equal by the next Plowing, or by the Drilling; but if many contiguous Ridges ſhould be too wide, or too narrow, 'twill be difficult to bring them all to an Equality afterwards, without levelling the whole Piece, and laying out the Ridges all anew.

The exact Height of Ridges, which is beſt, I cannot determine (*d*): A different Soil may require a different Height, according to the Depth, Richneſs, and Pulveration of the Mould. As Wheat covets always to lie dry in the Winter, ſo there is no other way to keep it ſo dry as theſe Ridges; for when they are, after the firſt Hoeing, about Eighteen Inches broad,

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(*c*) But if the Piece be of ſuch a crooked or ſerpentine Form, that the Ridges cannot well be plow'd ſtrait the firſt time, 'tis beſt to drill it upon the Level; and then the marking Wheels may direct for making the Row all parallel and equidiſtant; which will guide the Plough to make all the Ridges for the next, and all the ſubſequent Crops, as equal.

(*d*) I find by meaſuring my Wheat Ridges in the Spring, that none of them are quite a Foot high; and ſome of them only Six Inches; but I know not how much they have ſubſided in the Winter; for they were certainly higher when firſt made.

broad *(a)*, with a Ditch on each Side, of almoſt a Foot deep, the Rain-water runs off ſuch narrow Ridges as faſt as it falls, and much ſooner *(b)* than 'tis poſſible for it to do from broad Ridges.

And the deeper the Soil, the more occaſion there commonly is of this high Situation; becauſe ſuch Land is wetter, for the moſt part, than ſhallow Land, where we cannot make the Furrows ſo deep, nor the Ridges ſo high *(c)*, as in deep Land; for we muſt never plow below the Staple. I ſee the Wheat on theſe ho'd Ridges flouriſh, and grow vigorouſly, in wet Weather, when other Wheat looks yellow and ſickly.

The ſame wide Interval, which is ho'd betwixt Ridges the Firſt time, with Two Furrows, muſt have had Four Furrows, to hoe it on the Level; or elſe the Furrow, that is turn'd from the Row, would riſe up, and a great Part of it fall over to the Left-hand, and bury the Row; but when turn'd from a Ridge, it will all fall down to the Right-hand.

You muſt not leave the Tops of the Ridges quite ſo narrow and ſharp for Drilling of Wheat, as you may for drilling Turneps; Wheat being in treble Rows, but Turneps generally in ſingle Rows *(d)*. This is our Method of making Ridges for the Firſt Crop of drill'd Wheat.

(*a*) This is the Breadth the Ridges are generally left at, when the Furrows are hoed from them, and thrown into the Intervals.

(*b*) Water, when it runs off very ſoon, is beneficial, as is ſeen in water'd Meadows; but where it remains long on, or very near the Bodies of terreſtrial Plants, it kills them, or at leaſt is very injurious to them.

(*c*) If we ſhould make our Ridges as high on a ſhallow Soil, as we may on a deep Soil, there would be a Deficiency of Mould in the Intervals of equal Breadth with thoſe of a deep Soil.

(*d*) A ſingle Row taking up leſs of the Breadth, may be afforded to have more of the Ridge's Depth; becauſe it leaves the Interval wider.

But the Method of making Ridges for a ſucceeding Crop, after the former is harveſted, is beſt perform'd as follows: In making Ridges for Wheat after Wheat, you muſt raiſe them to their full Height, before you plow the old Partitions, with their Stubble, up to them; for if you go about to make the Ridges higher afterwards, the Stubble will ſo mix with the Mould of their Tops, that it may not only be an Hindrance to the Drill, but alſo to the Firſt Hoeing; becauſe if the Hoe-plough goes ſo near to the Rows as it ought, it would be apt to tear out the Wheat-plants along with the Stubble.

In Reaping, we cut as near as we can to the Ground *(a)*; which is eaſily done, becauſe the Stalks ſtand all cloſe together at Bottom, contrary to thoſe of ſown Wheat.

I find this Stubble, when 'tis only mixt with the Intervals, very beneficial to the Hoeing of my Wheat; but I know not whether it may be ſo in rich miry Land.

As ſoon as conveniently you can, after the Crop of Wheat is carried off (if the Trench in the Middle of each wide Interval be left deep enough by the laſt Hoeing), go as near as you can to the Stubble with a common Plough, and turn Two large Furrows into the Middle of the Intervals, which will *(b)* make a Ridge

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(*a*) When Wheat is reap'd very low, the Stubble is no great Impediment; and I do this when I am forc'd to inlarge the Breadth of my Ridges, or to change their Bearing, as I do when I find it convenient for them to point Croſs-ways of the Field inſtead of Length-ways; as if one End of it be wetter than the other: For 'tis inconvenient, that one End of a Ridge ſhould be in the wet Part, and the other in the dry; becauſe, in that Caſe, we cannot hoe the dry End without hoeing the wet at the ſame time; and whilſt we attend for the wet Part to become dry, it may happen, that the Seaſon for hoeing the Whole (if the Quantity be great) may be loſt.

(*b*) 'Tis the Depth and Fineneſs of this Ridge that the Succeſs of our Crop depends on; the Plants having nothing elſe to maintain

Ridge over the Place where the Trench was: But if the Trench be not deep enough, go firſt in the Middle of it with one Furrow; which, with Two more

tain them during the Firſt Six Months; and if, for want of Suſtenance, they are weak in the Spring, 'twill be more difficult to make them recover their Strength afterwards ſo fully as to bring them to their due Perfection. But Ploughmen have found a Trick to diſappoint us in this fundamental Part of our Huſbandry, if they are not narrowly watched: They do it in the following Manner; *viz.* They contrive to leave the Trench very ſhallow; and then, in turning the Two Firſt Furrows of the Ridge, they hold the Plough towards the Left, which raiſes up the Fin of the Share, and leaves ſo much of the Earth whereon the Rows are to ſtand whole and unplowed, that after once Harrowing there doth not remain above Two or Three Inches in Depth of fine Earth underneath the Rows when drilled, inſtead of Ten or Twelve Inches.

On a time, when my Diſeaſes permitted me to go into the Wheat-field, where my Ploughs were at Work, I diſcovered this Trick, and ventured to aſk my chief Ploughman his Reaſon for doing this in my Abſence, contrary to my Directions. He magiſterially anſwer'd, according to his own Theory, which Servants judge ought to be follow'd before that of him they call Maſter, ſaying, That as the Roots of Wheat never reached more than Two or Three Inches deep, there was no need that the fine Mould ſhould be any deeper. But thoſe ſhallow Ridges, which were indeed too many, producing a Crop very much inferior to the contiguous deep Ridges, ſhewed, at my Coſt, the Miſtake of my cunning Ploughman.

'Tis true, that People who examine Wheat-roots when dead, are apt to fall into this Miſtake; for then they are ſhrivell'd up, and ſo rotten, that they break off very near to the Stalk in pulling up; but if they are examined in their Vigour at Summer with Care, in a friable Soil, they may be ſeen to deſcend as deep as the fine pulveriz'd Mould reacheth, though that ſhould be a Foot in Thickneſs.

I took up a Wheat-ear in Harveſt that had lain on the Graſs in wet Weather, where the Wind could not come to dry it, which had ſent out white Roots like the Teeth of a Comb, ſome of them Three Inches long: None having reached the Ground, they could not be nouriſhed from any thing but the Grains, which remained faſt to the Ear, and had not as yet ſent out any Blade. 'Tis unreaſonable to imagine, that ſuch a ſingle Root as one of theſe, when in the Earth, from whence it muſt maintain a pretty large Plant all or moſt Part of the Winter, ſhould deſcend no farther than when it was itſelf maintained from the Flour of the Grain only.

taken from the Ridges, will be Three Furrows in each Interval; continue this Plowing as long as the dry Weather laſteth; and then finiſh, by turning the Partitions (whereon the laſt Wheat grew) up to the new Ridges, which is uſually done at Two great Furrows. You may plow theſe laſt Furrows, which complete the Ridges, in wet Weather.

To make a Six-feet Ridge very high, will ſometimes require more Furrows; as when the Middle of the Intervals are open very wide and deep, then Six Furrows to the whole Ridge may be neceſſary, and they not little ones; and the Seaſon makes a Difference, as well as the Size of the Furrows; for when the fine Mould is very dry (which is beſt), it will much of it run to the Left-hand before the Plough, and alſo more will run back again to the Left after the Plough is gone paſt it.

But when ſuch Ridges have been made for Wheat, and the Seaſon continues long too dry for planting it, and the Stubble not thrown up, we then plow one deep Furrow on the Middle of each Ridge, and then plow the whole Ridge at Four Furrows more, which will raiſe it very high. This way of re-plowing the Ridges moves all the Earth of them, and yet is done at Five Furrows.

The Furrows, neceſſary for raiſing up the Ridges, muſt be more, or fewer, in regard to the Bigneſs of them; becauſe Six ſmall Furrows may be leſs than Four great ones. 'Tis not beſt to plow the Stubble up to the Ridges, until juſt before Planting (eſpecially in the early Plowing); becauſe that will hinder the Re-plowing of the Firſt Furrows, which, if the Seaſon continues dry, may be neceſſary: Sometimes we do this by opening One Furrow in the Middle of the Ridge, ſometimes Two, and afterwards raiſe up the Ridges again; and when they are become moiſt enough at Top (the old Partitions being plow'd up to them), we harrow them once *(a)* (and that only Lengthways); and then drill them.

There is a Neceſſity of plowing the old Partitions up to the new Ridges, to ſupport their other Earth from falling down by the Harrowing and Drilling, which would elſe make them level.

Our Ridges, after the Firſt time of Plowing, excel common Ridges of the ſame Height; becauſe theſe, tho' as deep in Mould at the Tops, have little of it till'd at the laſt Plowing; but ours, being made upon the open Trenches, conſiſt of new-till'd pulveriz'd Mould, from Top to Bottom.

'Tis a general Rule, that all ſorts of Grain and Seeds proſper beſt, ſown when the Ground is ſo dry, as to be broken into the moſt Parts by the Plough. The Reaſon why Wheat is an Exception to that Rule is, becauſe it muſt endure the Rigours of Winter, which 'tis the better able to do, by the Earth's being

(*a*) But if once be not ſufficient to level the Tops of the Ridges fit for the Drill to paſs thereon, as it always will, unleſs the Two hard Furrows lie ſo high, that all the Three Shares of the Drill cannot reach to make their Chanels, in this Caſe you muſt harrow again until they can all reach deep enough. Alſo in ſome ſort of Land, that, when drilled late, and very moiſt, will ſtick to the Shares like Pitch or Bird-lime, whereby the Chanels are in Part left open by the Drill-harrow, it muſt be harrowed after 'tis drilled, becauſe 'tis neceſſary in ſuch Land to take off the common Drill-harrow, in order for a Man to follow the Drill with a Paddle, or elſe a forked Stick, with which he frees the Sheats of the adhering Dirt; this Harrow being gone, much of the Seed will lie uncovered, and then muſt be covered with common Harrows; unleſs a Drill-harrow, which was not in Uſe when my Plates were made, be placed inſtead of that taken off: This, with its two Iron *Tines*, will cover the Seed in this Caſe much better than common Harrows, and will be no Hindrance to cleanſing of the Sheats, the Legs by which this Harrow is drawn, being remote from them, placed at near the End of the Plank; and *note*, that the moſt proper Drill for this Purpoſe is one that has only Two Shares, ſtanding a Foot or Fourteen Inches aſunder: This Harrow ſerves for taking up the Drill to turn it.

preſs'd or trodden harder, and cloſer to it *(a)*, as it is when moved wet.

If Wheat were as hardy as Rye, and its Roots as patient of Cold, it might, no doubt, be ſown in as dry a Seaſon as Rye is, and proſper the better for it, as Rye doth. This will appear, if Wheat and Rye be both ſown in the ſame dry Seaſon, after the Winter is over.

But as Wheat requires to have the Earth lie harder on and about it, in the Winter; ſo it alſo requires more Dung (or ſomewhat elſe) to diſſolve the Earth about its Roots, after the cold Winter is paſt, than Rye doth, whoſe Roots never were ſo much confined.

'Tis another general Rule, that all ſorts of Vegetables thrive beſt, when ſown on freſh-till'd Ground, immediately after 'tis plow'd.

Wheat is an Exception to this Rule alſo; for 'tis better to plow the Ground dry, and let it lie till the Weather moiſtens it (tho' it be ſeveral Weeks), and then drill the Wheat: The Harrows and the Drill will move a ſufficient Part of the Ground, which will ſtick together for Defence of the ſmall Roots, during the Winter, the reſt of the Mould lying open, and divided underneath until Spring, to nouriſh them.

There is a ſort of binding Sand, that requires not only to be plow'd dry, but ſow'd dry alſo; or elſe the Wheat will dwindle in the Spring, and fail of being a tolerable Crop.

But what I mean by dry Plowing is, not that the Land ſhould always be ſo void of Moiſture, as that the Duſt ſhould fly; but it muſt not be ſo wet, as to ſtick together *(b)*. Neither ſhould we drill when

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(*a*) 'Tis for that Reaſon, that Farmers drive their Sheep over very light Land, as ſoon as 'tis ſown with Wheat, to tread the (Top, or) Surface of it hard; and then the Cold of the Winter cannot ſo eaſily penetrate, to kill the Roots of the tender Plants.

(*b*) But the drier 'tis plow'd, the better.

the Earth is wet as Pap; it ſuffices that it be moiſt, but moiſter in light Land, than in ſtrong Land, when we drill.

If the Two Furrows, whereon the treble Row is to ſtand, be plow'd wet, the Earth of the Partitions may grow ſo hard by the Spring, that the Roots cannot run freely therein, unleſs there be Dung to ferment and keep it open.

So we ſee, that a ſteep Bank, made of wet Earth, will lie faſt for ſeveral Years, when another, made of the ſame Earth dry, will moulder, and run down very ſoon; becauſe its Parts have not the Coheſion that holds the other together, it continues open, and more porous, and crumbles continually down.

I have ſeen Trials of this Difference betwixt plowing Dry, and plowing Wet, for planting of Wheat, both in the Old way, and in the Drilling way, but moſt in the latter; and never ſaw an Inſtance where the Dry-plowing did not outdo the Wet; if the Wheat was not planted thereon before the Earth was become moiſt enough at Top.

And ſtrong Land, plow'd wet in *November*, will be harder in the Spring, than if plow'd dry in *Auguſt*; tho' it would then have Three Months longer to lie.

After Rain, when the Top of the Ground is of a fit Moiſture for Drilling, harrow it with Two light Harrows, drawn by a Horſe going in the Furrow betwixt Two Ridges *(a)*; once will be enough, the Furrow being juſt broken to level, or rather ſmooth it for the Drill.

If the Veerings *(b)* whereon the next Crop is to ſtand, be plow'd dry, we may drill at any time during

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(*a*) Once Harrowing is generally enough, but not always.

(*b*) The word Veering is, I believe, taken from the Seamen, and ſignifies to turn: It is the Ploughman's Term for turning Two Furrows toward each other, as they muſt do to begin a Ridge; and during the common and uſual Wheat-ſeed-time, that is proper for the ſort of Wheat to be drill'd, and the ſort of Land, whether that be early or late, we may drill earlier, but not later than the ſowing Farmers. But I have had good Crops of Wheat drill'd at all times betwixt Harveſt, and the Beginning of *November*.

For the Benefit of the middle Rows, 'tis better not to drill Wheat on ſtrong Land before the uſual Seaſon; becauſe the later 'tis planted, the more open the Partitions will be for the Roots of thoſe Rows to run through them in the Spring: and yet, if the Earth of the Partitions be plow'd very wet, tho' late, they may be harder at the Spring, than thoſe which are plow'd early and dry.

There is a ſort of Wheat call'd by ſome (a) *Smyrna Wheat*: It has a prodigious large Ear, with many leſs (or collateral) Ears, coming all round the Bottom of this Ear; as it is the largeſt of all ſorts of Wheat, ſo it will diſpenſe with the Nouriſhment of a Garden, without being over-fed, and requires more Nouriſhment than the common Huſban-

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and therefore they call the Top of a Ridge a Veering; they call the Two Furrows that are turn'd from each other at the Bottom, between Two Ridges, a Henting, *i.e.* an Ending; becauſe it makes an End of plowing Ridges.

Our Intervals wholly conſiſt of Veerings or Hentings; when Two Furrows are turn'd from the Rows, they make a Veering; when turn'd towards the Rows, they are a Henting, which is the deep wide Trench in the Middle of an Interval.

(a) 'Tis ſaid to grow moſtly in ſome Iſlands of the *Archipelago*, and ſome Author deſcribes it *Triticum ſpica multiplici*: There is another ſort of Wheat that has many little Ears coming out of Two Sides of the main Ear; but this is very late ripe, and doth not ſucceed well here, nor is it liked by them, who have ſown it; yet I have had ſome Ears of it by chance among my drill'd Wheat, which have been larger than thoſe of any common Sort. I have not as yet been able to procure any of the *Smyrna Wheat*, which I look on as a great Misfortune; but I had ſome of it above Forty Years ago.

dry will afford it; for there its Ears grow not much bigger than thoſe of common Wheat: This I believe to be, for that Reaſon, the very beſt ſort for the Hoeing Huſbandry; next to this I eſteem the White-cone Wheat, then the Grey-cone. I have had very good Crops from other Sorts; but look upon theſe to be the beſt.

When Wheat is planted early, leſs Seed is required, than when late; becauſe leſs of it will die in the Winter, than of that planted late, and it has more time to tiller (*a*).

Poor Land ſhould have more Seed than rich Land, becauſe a leſs Number of the Plants will ſurvive the Winter on poor Land.

The leaſt Quantity of Seed may ſuffice for rich Land that is planted early; for thereon very few Plants will die; and the Hoe will cauſe a ſmall Number of Plants to ſend out a vaſt Number of Stalks, which will have large Ears; and in theſe, more than in the Number of Plants, conſiſts the Goodneſs of a Crop (*b*).

Another thing muſt be conſider'd, in order to find the juſt Proportion of Seed to plant; and that is, that ſome Wheat has its Grains twice as big as other Wheat of the ſame Sort; and then a Buſhel (*c*) will contain but half the Number of Grains; and One Buſhel of Small-grain'd Wheat will plant as much Ground as Two Buſhels of the Large-grain'd; for, in truth, 'tis not the Meaſure of the Seed, but the Number of the Grains, to which reſpect ought to be had in apportioning the Quantity of it to the Land.

(*a*) To *tiller* is to branch out into many Stalks, and is the Country Word, that ſignifies the ſame with *fruticare*.

(*b*) A too great Number of Plants do neither tiller, nor produce ſo large Ears, nor make half ſo good a Crop, as a bare competent Number of Plants will.

(*c*) Our Buſhel contains Seventy Pounds of the beſt Wheat.

Some have thought, that a large Grain of Wheat would produce a larger Plant than a ſmall Grain; but I have full Experience to the contrary. The ſmall Grain, indeed, ſends up its firſt ſingle Blade in proportion to its own Bulk; but afterwards becomes as large a Plant, as the largeſt Grain can produce *(a)*, *cæteris paribus*.

Six Gallons of middle-ſiz'd Seed we moſt commonly drill on an Acre; yet, on rich Land planted early, Four Gallons may ſuffice; becauſe then the Wheat will have Roots at the Top of the Ground before Winter, and tiller very much, without Danger of the Worms, and other Accidents, that late-planted Wheat is liable to.

If it is drill'd too thick, 'twill be in Danger of falling; if too thin, it may happen to tiller ſo late in the Spring, that ſome of the Ears may be blighted; yet a little thicker or thinner does not matter.

As to the Depth, we may plant from half an Inch, to Three Inches deep; if planted too deep, there is more Danger of its being eaten off by Worms, betwixt the Grain and the Blade *(b)*; for as that

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(*a*) Farmers in general know this, and chooſe the thinneſt, ſmalleſt-grained Wheat for Seed; and therefore prefer that which is blighted and lodged, and that which grows on new-broken Ground, and is not fit for Bread; not only becauſe this thin Wheat has more Grains in a Buſhel; but alſo becauſe ſuch Seed is leaſt liable to produce a ſmutty Crop, and yet brings Grains as large as any.

I myſelf have had as full Proofs of this as can poſſibly be made, in both reſpects.

'Twas from ſuch ſmall Seed that my drill'd *Lammas* Wheat produced the Ears of that monſtrous Length deſcribed in this Chapter. I never ſaw the like, except in that one Year; and the Grains were large alſo.

And as full Proofs have I ſeen of thin Seed-wheat eſcaping the Smut, when plump large-grain'd Seed of the ſame ſort have been ſmutty.

(*b*) A Wheat-plant, that is not planted early, ſends out no Root above the Grain before the Spring; and is nouriſh'd all the Winter by a ſingle Thread, proceeding from the Grain up to the Surface of the Ground.

Thread is the Thread of Life during the Winter (if not planted early), ſo the longer the Thread is, the more Danger will there be of the Worms (*a*).

'Tis a neceſſary Caution to beware of the Rooks (*b*), juſt as the Wheat begins to peep; for before

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(*a*) Becauſe the Worms can more eaſily find a Thread, that extends by its Length to Five or Six Inches Depth, than one which reaches but One Inch; and beſides, the Worms in Winter do not inhabit very near the Surface of the Ground; and therefore alſo miſs the ſhort Threads, and meet with the long ones.

(*b*) 'Tis true, that Wheat which is planted early enough for its Grain to be unfit for the Rooks, before the Corn that is left on the Ground at Harveſt, is either all eaten by them, or by Swine, or elſe grow'd, plowed in, or otherwiſe ſpoiled, is in no Danger; but as this ſometimes happens ſoon after Harveſt, the time of which is uncertain, a timely Care is neceſſary.

Many are the Contrivances to fright the Rooks; *viz.* To dig an Hole in the Ground, and ſtick Feathers therein; to tear a Rook to Pieces, and lay them on divers Parts of the Field: This is ſometimes effectual; but Kites or other Vermin ſoon carry away thoſe Pieces. Hanging up of dead Rooks is of little Uſe; for the living will dig up the Wheat under the dead ones. A Gun is alſo of great Uſe for the Purpoſe; but unleſs the Field in time of Danger be conſtantly attended, the Rooks will at one time or other of the Day do their Work, and you may attend often, and yet to no Purpoſe; for they will do great Damage in your Abſence.

The only Remedy that I have found infallible is a Keeper (a Boy may ſerve very well) to attend from Morning until Night; when he ſees Rooks either flying over the Field, or alighted in it, he halloos, and throws up his Hat, or a dead Rook, into the Air; upon which, they immediately go off; and 'tis ſeldom that any one will alight there: They, finding there is no Reſt for them, ſeek other Places for their Prey, wherein they can feed more undiſturbed.

This was the Expedient I made uſe of for preſerving my preſent Crop: It ſucceeded ſo well, that, in Sixſcore Acres, I believe there is not Two-pence Damage done by the Rooks; but I had two Boys (one at Four-pence, and the other at Three-pence a Day) to attend them; becauſe my Wheat is on Two ſides of my Farm; the whole Expence was about Twenty Shillings. The Damage I received by Rooks the laſt Year in a Field of Seventeen Acres, was more than would have, in this manner, preſerved my whole Crops for Twenty Years running. I wiſh I could as eaſily defend my Wheat againſt Sheep, which are to me a more pernicious Vermin than the Rooks.

you can perceive it to be coming up, they will find it, and dig it up to eat the Grain; therefore you muſt keep them off for a Week or Ten Days; and in that time the Blade will become green, and the Grain ſo much exhauſted of its Flour, that the Rooks think it not worth while to dig after it.

But the Rooks do not moleſt Wheat that is planted before or a little after St. *Michael*; for then there remains Corn enough in the Fields, which is left at Harveſt above-ground, that Rooks prefer always before Corn which muſt coſt them the Labour of digging to find it.

Of Partitions.

I have now intirely left out the middle Row for Wheat, and keep only to the double Row, for the following Reaſons.

It makes the cleanſing from Weeds more difficult, than when there is only a double Row.

The Hand-hoe cannot give near ſo much Nouriſhment (*i. e.* pulverize ſo much Earth) in Two Seven-inch Partitions, as it can in One Ten-inch Partition.

There is Four Inches leſs Earth to be pulveriz'd by the Horſe-hoe from the Surface of a Ridge that has Two Seven-inch Partitions, than from a Ridge that hath One Ten-inch Partition.

The Ridge muſt be almoſt twice as deep in Mould for the treble as for the double Row, or elſe the middle Row will be very weak and poor; and then, according to the Principles, the whole Ridge will be more exhauſted, than by an equal Product produced by ſtrong Plants.

As the Ridges may be much lower that have only the one Partition, ſo the Intervals may be narrower, and yet have as much Earth in them to be pulveriz'd, as in wide ones that are betwixt treble Rows; becauſe the Four Inches that are in the two Partitions more than in the ſingle Partition, being on the Top of the Ridge, may have more Mould under them than Eight Inches on the ſide of a Ridge; and the Four Inches, being in the Partitions, loſe the Benefit of Horſe-hoeing.

Inſtead of uſing the middle Row as an Alloy, 'tis better to plant ſuch ſorts of Wheat as do not require any Alloy to the double Row; and theſe are the *White-cone*, and above all other ſorts the right *Smyrna*.

The *White-cone* Wheat muſt not be reaped ſo green as the *Lammas* Wheat may; for if it is not full-ripe, it will be difficult to threſh it clean out of the Straw.

It happened once that my *White-cone* being planted early, and being very high, the Blade and Stalk were kill'd in the Winter; and yet it grew high again in the Spring, and had then the ſame Fortune a Second time; it lay on the Ridges like Straw, but ſprung out anew from the Root, and made a very good Crop at Harveſt: Therefore, if the like Accident ſhould happen, the Owner needs not be frighted at it.

One thing that made Six-feet Ridges ſeem at firſt neceſſary, was the great Breadth of the Two Partitions (which were Eight Inches apiece), which, together with the Earth left on each ſide of the treble Row not well cleanſed by Hand-work, made Two large whole Furrows, at the firſt Plowing for the next Crop, that could not be broken by Harrows: Theſe Two ſtrong Furrows, being turned to the Two Furrows that are in the middle of a narrow Interval, for making a new Ridge, would cover almoſt all the pulveriz'd Earth, not leaving room betwixt the Two whole Furrows for the Drill to go in. But now the ſingle Partition, and the Earth left by the Hoe-plough, on the Outſides of the double Row, making Two narrow Furrows, and the one Partition being cleanſed, and deeper Hand-ho'd than thoſe of the treble Row were, or could be, are eaſily broken by the

Harrows; for, beſides their Narrowneſs, they have no Roots to hold their Mould together, except the Wheat-roots, which, being ſmall and dead, have not Strength enough to hold it; and therefore that Neceſſity of ſuch broad Ridges now ceaſes along with the treble Row.

When the Two narrow fragile Furrows are harrowed, and mixed with the pulveriz'd Earth of the Intervals; the Roots of the Wheat will reach it; and it is no matter whether the Crop be drill'd after Two Plowings, in which caſe the Row will ſtand on the very ſame Place whereon the Row ſtood the precedent Year, or whether it be drill'd after One or Three Plowings; and then the Rows will ſtand on the Middle of the laſt Year's Intervals.

I cannot preſcribe preciſely the moſt proper Width of all Intervals; becauſe they ſhould be different in different Circumſtances. In deep rich Land they may be a little narrower than in ſhallow Land.

There muſt be (as has been ſaid) a competent Quantity of Earth in them to be pulveriz'd; and, when the Soil is rich, the leſs will ſuffice.

Never let the Intervals be too wide to be Horſe-hoed at Two Furrows, without leaving any Part unplowed in the Middle of them, when the Furrows are turned towards the Rows.

Some Ploughmen can plow a wider Furrow than others, that do not underſtand the ſetting of the Hoe-plough ſo well, can.

By making the Plank of the Hoe-plough ſhorter, and the Limbers more crooked, we can now hoe in narrower Intervals than formerly, without doing any Damage to the Wheat.

I now chooſe to have Fourteen Ridges on an Acre, and one only Partition of Ten Inches on each of them. This I find anſwers all the Ends I purpoſe. If the Partitions are narrower, there is not ſufficient room in them for the Hand-hoe to do its work effectually;

ally; if wider, too much Earth will loſe the Benefit of the Horſe-hoe.

The poorer the Soil is, the more Pulveration will be neceſſary to it.

When a great Seaſon of Wheat is drill'd, it cannot be expected that much of it can be plowed dry, tho' it is advantageous when there happens an Opportunity for doing it; but by long Experience I find, that in moſt of my Lands it does very well, when plowed in a moderate Temper of Moiſture.

It may not be amiſs to harrow it once after it is drill'd, which will, in ſome meaſure, diſappoint the Rooks; beſides covering the Wheat, if, perchance, any ſhould miſs being covered by the Drill-harrow.

But theſe, and all Harrows that go on a Ridge, both before and after it is drill'd, ſhould be very light, and faſtened together in the common manner; except that the Pole muſt be faſtened to each Harrow in Two Places; which keeps them both as Level, as if they were One ſingle Harrow: Otherwiſe the Ridges would be too ſharp at the Top, and the Partitions would lie higher than the Rows, and ſome of their Earth would be apt to fall on the Rows when it is Hand-hoed.

By means of this level Harrowing, there is left an open Furrow in the Middle of the Interval, which much facilitates the Firſt Horſe-hoeing.

But when, after a Crop is taken off, the Ridges are plowed twice, as they may be where the one Partition hath been well Hand-ho'd; 'tis better to harrow the firſt-made Ridges in the common manner; becauſe then ſome of the fine Earth, that is harrow'd down, will reach to the Middle of the Intervals whereon the Ridges are to be made for Drilling: Or if there ſhould be time for plowing thrice, the Ridges of the Firſt and Second Plowings, are to be harrow'd in the common manner alſo.

The Harrowing of Ridges muſt never be croſs-ways, unleſs they are to be made level for Croſs-plowing, in order to lay out the Ridges of a Breadth different to what they were of before.

When you perceive the Ridges are too high, harrow them lower by the deſcribed manner of Harrowing; firſt with the heavy Harrows for harrowing out the Stubble, and then with light ones, which may be often, for making the Earth on the Ridges the finer for Drilling, without throwing much of it down; frequent Harrowings in this manner, not being injurious like too much Harrowing on level Ground, which is ſometimes trodden as hard as the Highway by the Cattle that draw the Harrows; for in harrowing theſe Ridges, the Beaſt draws the Two Harrows, and always treads in the Furrow between them, where there is none or very little Mould to tread on.

The Price of Hand-hoeing of theſe double Rows is a Peny for Thirty Perches in Length of Row, which amounts to between Eighteen and Nineteen Pence for an Acre.

I ſhould ſay, that in Hand-hoeing the Earth muſt never be turned towards the Wheat; for, if it were, it might cruſh it when young; neither could the Partition be clean hoed.

The Hand-hoes for hoeing the Ten-inch Partition have their Edges Seven Inches long; they are about Four Inches deep from the Handle; if they were deeper, they would be too weak; for they muſt be thin, and well ſteeled. The Labourers pay for them, and keep them in Order, for their own Uſe.

Theſe Hoes muſt not cut out any Part of the Two Rows, nor be drawn through them, as the Four-inch Hoes ſometimes may through the treble Rows.

If I am taxed with Levity in changing my treble Rows for double ones, it will not appear to be done of a ſudden. In *p.* 132, I adviſed the Trial of both

Sorts: And now, upon fuller Experience, I find the double Rows much preferable to the treble, eſpecially for Wheat.

When Gentlemen ſaw the middle Row on low Ridges ſo much inferior to the outſide Rows, they were convinced of the Effect of deep Hoeing; for they ſaid, there was no other Reaſon for this ſo viſible a Difference, except the outſide Rows ſtanding nearer to the pulveriz'd Intervals than the middle Row did.

And when on high Ridges the middle Row was nearly or quite as good as one of the outſide Rows, I was not convinced, that they were not diminiſhed by the middle Row, as much as the Produce of it amounted to: And this I now find to be the Caſe; for Four Rows of Oats, without a middle Row, produced ſomewhat more than the ſame Number that had a middle Row; Two of which treble Rows were taken on one Side, and Two on the other Side of the double Rows, purpoſely to make an unexceptionable Trial. And it is, as far as I can judge, the ſame in Wheat.

'Tis true, I began my Horſe-hoeing *Scheme* firſt with double Rows; but then they were different to what they are now; for the firſt had their Partition uneven, being the parting Space, whereby it was leſs proper for Hand-hoeing, which I then ſeldom uſed, except for abſolute Neceſſity, as to cleanſe our Poppies, and the like. The Intervals alſo were too narrow for conſtant annual Crops.

By all theſe Three Methods I have had very good Crops; but as this I now deſcribe is the lateſt, and is (as it ought to be) the beſt; I publiſh it as ſuch, without Partiality to my own Opinions; for I think it leſs diſhonourable to expoſe my Errors, when I chance to detect them, than to conceal them: And as I aim at nothing but Truth, I cannot, with any Satisfaction to my ſelf, ſuffer any thing of my own knowingly to eſcape, that is in the leaſt contrary to it.

I have a Piece of Five or Six Acres of Land which I annually plant with boiling Peaſe, in the very ſame manner as Wheat; except that the Second Horſe-hoeing (which is the laſt) throws the Earth ſo far upon the Peaſe as to make the Two Rows become One. Theſe Peaſe cannot be planted until after the 25th of *March*; elſe Two Horſe-hoeings might not be ſufficient. The ſame Drill that plants Wheat plants Peaſe; only ſometimes we change the Spindle for one that has its Notches a little bigger.

I drill no more Barley, becauſe 'tis not proper to be followed by a Crop of Wheat without a Fallow; for ſome of the ſhatter'd Barley will live over the Winter, and mix with the Wheat in the Rows, and can ſcarce poſſibly be thence timely taken out, its firſt Stalk and Blade being difficult to diſtinguiſh from the Wheat; and this is a great Damage to the Sale in the Market; and for the ſame Reaſon I plant no more Oats.

The Firſt Hoeing is perform'd by turning a Furrow from the Row.

We are not ſo exact as to the Weather in the Firſt Hoeing; for if the Earth be wet, the Hoe-plough may go nearer to the Row, without burying the Wheat; and the Froſt of the Winter will pulverize that Part of the (*a*) Furrow, which is to be thrown to the Wheat in the Spring, altho' it was ho'd wet.

Neither is it neceſſary to be very exact as to Time; but it muſt never be till the Wheat has more than One Blade; and it may be ſoon enough, when it has Four or Five Leaves, ſo that it is done before (*b*), or in the Beginning of Winter.

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(*a*) The Word Furrow ſignifies the Earth that is thrown out, as well as the Trench from whence it is thrown by the Plough.

(*b*) But if the Wheat is planted very late, it may not be *hoeable* before the Winter is paſt; nor is there ſuch a Neceſſity of hoeing

The greateſt Fault you can commit in Hoeing, is the Firſt time, when the Furrow is turn'd from the Row, not to go near enough to it, nor deep enough. You cannot then go too near it, unleſs you plow it out, or bury it with Mould, and do not uncover it; nor too deep, unleſs you go below the Staple of the Ground.

Servants are apt to hoe too far from the Rows, going backwards and forwards, in the Middle of the Intervals, without coming near the Rows: This loſes moſt of the Benefit of Hoeing, and is very injurious to the preſent Crop, and alſo to the Two ſucceeding Crops; for then there will be a Deficiency of pulveriz'd Earth; and nobody can ſuppoſe, that the ho'd Earth can be of any Benefit to the Rows, before the Roots reach into it; and when 'tis far off, few of the Roots reach it at all; and thoſe that do reach, come there too late to bring the Plants to their full Perfection: Therefore, if the Firſt Furrow was not near enough, nor deep enough, plow a Second Furrow at the Bottom of the former, which will go deeper than the Firſt, and break the Earth more; beſides taking away from the Rows ſuch unmov'd Ground, which the Firſt Plowing may poſſibly have miſs'd. If this can't be conveniently done ſoon after the Firſt Hoeing, do it before the Ridge is turn'd back in the Spring.

Always leave the Furrows turn'd up, to make (*a*) Ridges in the Middle of the Intervals during the Winter;

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hoeing the late-planted before the great Froſts are over, as there is of the early-planted; for the later 'tis planted, the leſs time the Earth has to ſubſide, and grow hard.

Note, By Winter we do not mean only thoſe Months that are properly ſo reckoned, but alſo ſuch other Months as have hard Froſts in them, as *January*, *February*, and ſometimes the Beginning of *March*.

(*a*) Tho' the Ridge in the Middle of the Interval ſhould, for want of ſufficient Mould, or otherwiſe, be too low to give Shelter, Winter; and then the hollow Furrows, or Trenches next the Rows, being enrich'd by the Froſt (*b*) and Rains (*c*), the Wheat will have the Benefit of them earlier in the Spring, than if the Trenches had been left open in the Middle of the Intervals.

The outſide Rows of Wheat, from which the Earth is ho'd off before or in the Beginning of Winter,

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ter, yet there is generally ſome Earth falls to the Left of the Hoe-plough, and lodges upon that Part which is left on the Outſide of the Row; which, notwithſtanding that Part be very narrow (as ſuppoſe Two or Three Inches), yet a ſmall Quantity of Earth lying thereon, ſo near to the outſide Row, gives an extraordinary Shelter to the young Wheat-plants that grow in it.

Shelter is a great Benefit to Wheat; but yet Nouriſhment is more; for in the Winter I ſee the Wheat-plants upon the moſt expoſed Part of the Ridge flouriſh, when ſingle Plants in the Bottom of the Furrow are in a very poor languiſhing Condition, without any Annoyance of Water, they being upon a Chalk Bottom.

(*b*) Froſt, if it does not kill the Wheat, is of great Benefit to it; Water or Moiſture, when it is frozen in the Earth, takes up more Room than in its natural State; this Swelling of the Ice (which is Water congeal'd) muſt move and break the Earth wherewith it is mixt; and when it thaws, the Earth is left hollow and open, which is a kind of Hoeing to it. This Benefit is done chiefly to and near the Surface; conſequently the more Surface there is, by the Unevenneſs of the Land, the more Advantage the Soil has from the Froſt.

This is another very great Uſe of the Ridge left in the Middle of the Interval during the Winter; becauſe that Ridge, and its Two Furrows, contain Four times as much Surface as when level. This thus pulveriz'd Surface, turn'd in in the Spring-hoeing, enriches the Earth, in proportion to its Increaſe of internal Superficies, and likewiſe proportionably nouriſhes the Plants, whoſe Roots enter it; and that Part of it wherein they do not enter, muſt remain more enrich'd for the next Crop, than if the Soil had remained level all the Winter.

(*c*) It is a vulgar Error that the Winter Rains do not enrich the Earth; and is only thought ſo, becauſe we do not ſee the Effect of them upon Vegetables, for lack of Heat in that Seaſon. But ſome Farmers have frequently obſerv'd, that one half of a Ground plow'd up juſt before Winter has produc'd a Crop of Barley as much better than the other Part plow'd up at the End of Winter, as is the Difference of a Dunging, even when there has been very little Froſt.

and left almoſt bare till the Spring, one would think ſhould ſuffer by the Froſt coming ſo near them *(d)*, or for want of Paſture: But it appears to be quite contrary; for where the Hoe has gone neareſt to a Row, its Plants thrive beſt: The Earth, which the Froſt hath pulveriz'd, being within the Reach of the young ſhort Roots, on that Side of the Row, from the Top to the Bottom of the Trench, nouriſhes them at firſt; and before the Plants have much exhauſted this, as they grow larger in the Spring, the Ridge from the Middle of the Interval is thrown to them, having a perfectly unexhauſted Paſture, to ſupply their increaſing Bulk with more Nouriſhment.

The Row ſtanding as it were on the Brink of this almoſt perpendicular Ditch, the Water runs off quickly, or doth not enter but a very little way into this ſteep Side; ſo that, the Earth at the Plants being dry, the Froſt doth not reach quite to all their Roots to hurt them, tho' the Diſtance from the Air to the Roots be very ſhort; and dry Earth doth not freeze as wet doth, neither is this Ditch much expos'd to the cold Winds.

The Spring-hoeing is perform'd after the great Froſts are paſt, and when the Weather will allow it; and then turn *(e)* the Ridge from *(f)* the Middle of the

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(d) In very light Land, perhaps, we muſt not hoe quite ſo near to the Rows of Wheat, as in ſtrong Land, for fear the Winter ſhould lay the Roots bare, and expoſe them too much to the Cold; but then we may be ſure, that, in this Caſe, the Roots will reach the Interval at a greater Diſtance than in ſtrong Land; yet ſuch very light Land is not proper for Wheat.

(e) 'Tis an errant Miſtake of the Vulgar, when they imagine that the immediate Benefit of freſh Earth to Plants is from that Part which remains uppermoſt; for 'tis from turning the impregnated pulveriz'd Side downwards, to be fed on by the Roots, that gives the *Pabulum* or Nouriſhment of the freſh Earth to Plants: The otherSide, being turn'd upwards, becomes impregnate alſo in a little time.

(f) But note, that when we ſee Weeds coming up near the Row in the Spring, we plow again from the Rows (and ſometimes

the Interval, to the Rows on each Side by Two Furrows as near as can be, without covering the Wheat; in doing which have regard to the Row only, without looking at the Middle of the Interval; for 'tis no matter if a little Earth be left there; the next Hoeing, or the next ſave one (*g*), will move it.

As to how many times Wheat is to be ho'd in the Summer, after this Spring Operation, it depends upon the Circumſtances (*h*) and Condition of the Land (*i*) and Weather (*k*); but be the Seaſon as it will, never ſuffer the Weeds to grow high, nor let any unmov'd Earth lie in the Middle of the Intervals long enough to grow hard; neither plow deep near the Rows in the Summer, when the Plants are large (*l*), but as deep in the Middle of the Intervals

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times can plow within one Inch of the Row) before we turn down the Mould from the Middle of the Interval.

(*g*) If at the next Hoeing we turn another Furrow towards the Row (which is ſeldom done), then 'tis the next that moves the remaining Earth, left in the Middle of the Interval: But if the next Hoeing be from the Row (as it generally is), then that covers the Middle of the Interval; and then 'tis the next Hoeing after that, that turns all the Earth clean out of the Middle of the Interval toward the Rows.

(*h*) If the Land was not ſufficiently till'd or ho'd in the precedent Year, it will require the more Hoeings in the following Year.

(*i*) The poorer the Land is, the more Hoeings it ſhould have.

(*k*) A wet Summer may prevent ſome of the Hoeings that we ſhould perform in a dry Summer.

(*l*) Our Hoeing deep near the Plants, when ſmall, breaks off only the Ends of the Roots; but after the Roots are ſpread far in the Interval, the greateſt Part of them, being then on the Right-hand Side of the Hoe-plough, might hold faſt on that Side, and not be drawn out; and then the whole Roots would be broken off cloſe to the Bodies of the Plants: Therefore at the Second deep Hoeing, that turns a Furrow from the Row in the Summer, we go about Four or Six Inches farther off from the Roots than the time before; but we go nearer or farther off, according to the Diſtance of Time between thoſe Two Hoeings: Yet we may hoe *ſhallow* near to the Plants at any time, without Injury to their Roots, but, on the contrary, it will be advantageous to them.

as the Staple will allow; turning the Earth towards the Wheat, eſpecially at the laſt Hoeing, ſo as to leave a deep, wide Trench in the Middle of each Interval.

We augment our Wheat-crops Four Ways; not in Number of Plants, but in Stalks, Ears, and Grains.

The Firſt is, by increaſing the Number of Stalks from One, Two, or Three, to Thirty or Forty to a Plant, in ordinary Field-land.

And we augment the Crop, by bringing up all the Stalks into Ears, which is the Second Way; for, if it be diligently obſerv'd, we ſhall find, that not half (*m*) the Stalks of ſown Wheat come into Ear.

I ſaw an Experiment of this in Rows of Wheat that were equally poor: One of theſe Rows was increaſed (*n*) ſo much, as to produce more Grains than Ten of the other, by bringing up more of its Stalks into Ears, and alſo by augmenting its Ears to a much greater Bigneſs; which is the Third Way: For, whatever *Varro* means by ſaying, that the Ears remain Fifteen Days *in Vaginis*, 'tis pretty plain, that the Ears are form'd together with the Stalks, and will be very large, or very ſmall, in proportion to the Nouriſhment given them (*o*).

The laſt and Fourth Way of augmenting the Produce of Wheat-plants, is by cauſing them to have large and plump Grains in the Ears; and this can no way be ſo effectually done as by late Hoeing, eſpeci-

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(*m*) If a ſquare Yard of ſown Wheat be mark'd out, and the Stalks thereon number'd in the Spring, it will be found, that Nine Parts in Ten are miſſing at Harveſt.

(*n*) Theſe Rows were drill'd a Foot aſunder, not ho'd; and were, by the Shallowneſs and Wetneſs of the Soil, very poor in the Spring; and then, by pouring Urine to the Bottom of this Row, it was ſo vaſtly increaſed above the reſt.

(*o*) Like as the Vines, if well nouriſhed, bring large Bunches of Grapes; but if ill nouriſhed, they produce few Bunches, and thoſe ſmall ones; and many Claſpers are formed, which would have been Bunches, if they had had ſufficient Nouriſhment given them at the proper time.

ally juſt after the Wheat is gone out of the Bloſſom; and when ſuch ho'd Grains weigh double the Weight of the ſame Number of unho'd (which they frequently will) tho' the Number of Grains in the Ho'd are only equal, yet the ho'd Crop muſt be double.

Thus, by increaſing the Number of Stalks (*p*), bringing more of them up into Ear (*q*), making the Ears larger (*r*), and the Grain plumper, and fuller of Flour (*s*), the Hoeing Method makes a greater Crop from

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(*p*) The ſame Plant that, when poor, ſends out but Two or Three Tillers, would, if well nouriſhed by the Hoe, or otherwiſe, ſend up a Multitude of Tillers, as is ſeen in ho'd Wheat, and ſown Wheat.

(*q*) Mr. *Houghton* relates Eighty Ears on one ſingle Plant of Wheat, and a greater Number has been counted lately in a Garden: Thoſe Eighty, reckon'd to have Fifty Grains apiece, make an Increaſe of Four thouſand Grains for one; but I have never found above Forty Ears from a ſingle Plant in my Fields; yet there is no doubt, but that every Plant would produce as many as Mr. *Houghton*'s, of the ſame Sort, with the ſame Nouriſhment: But I ſhould not deſire any to be ſo prolific in Stalks, leſt they ſhould fail of bringing ſuch a Multitude of Ears to Perfection. The Four hundred Ears, that I number'd in a Yard, were not weigh'd, becauſe they were told before ripe; and the greateſt Weight of Wheat that ever I had from a Yard, was the Product of about Two hundred and Fifty Ears, and ſome of them were ſmall.

(*r*) I have number'd One hundred and Nine Grains in One Ear of my ho'd Cone-wheat of the grey Sort; and One Ear of my ho'd Lammas-wheat has been meaſured to be Eight Inches long, which is double to thoſe of ſown Wheat. I have ſome of theſe Ears now by me almoſt as long, the longeſt being given away as a Rarity; and indeed 'tis not every Year that they grow to that Length, and 'tis always where the Plants are pretty ſingle. But there is no Year wherein one Ear of my ho'd does not more than weigh Two of the ſown Ears, taking a whole Sheaf of each together without chooſing. The Sheaves of the ho'd are of a different Shape from the other; almoſt all the Ears of the ho'd are at the Top of the Sheaf; but moſt of the other are ſituate at the lower Part, or near the Middle of the Sheaf.

(*s*) Seed Cone-wheat coming all out at the ſame Heap, planted all at the ſame Time, and on Land of the ſame Sort adjoining near together, the Wheat that was ſown produc'd Grains ſo ſmall, and from a Tenth Part of the Plants (*t*) that the ſowing Method can.

All

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and that which was drill'd ſo very large, that no Farmer or Wheat-buyer would believe them to be of the ſame Sort of Wheat, except thoſe who knew it, which were many. One Grain of the drill'd weigh'd Two of the ſown, and there was twice the Chaff in an equal Weight of the ſown, being both weigh'd before and after the Wheat was ſeparated from the Chaff.

(*t*) The Fact of this nobody can doubt, who has obſerved the different Products of ſtrong and of weak Plants, how the one exceeds the other.

The greateſt Difference of having an equal Crop from a ſmall Number of ſtrong Plants, and from a great Number of weak ones, is, that the Soil is vaſtly leſs exhauſted by the former than by the latter, not only from the latter's exhauſting more in proportion to their Number when young, and whilſt each of them conſumes as much Nouriſhment as each of the ſmall Number; but alſo from the different Increaſe that a ſtrong Plant makes by receiving the ſame Proportion of Food with a weak one: For it appears from Dr. *Woodward*'s Experiments, that the Plant which receives the *leaſt* Increaſe carries off the *greateſt* Quantity of Nouriſhment in proportion to that Increaſe; and that 'tis the ſame with an Animal, all who are acquainted with fatting of Swine know; for they eat much more Food daily for the firſt Two Weeks of their being put into the Sty, than they do afterwards, when they thrive faſter; the fatter they grow, the leſs they eat.

Hence, I think, it may be inferred, that a Plant, which, by never having been robbed or ſtinted by other Plants, is ſtrong, receives a much greater Increaſe from an equal Quantity of Food, than a Number of weak Plants (as thick ones are), equalling the Bulk of the ſingle ſtrong Plant, do.

And this of the Doctor's have I ſeen by my own Obſervations confirmed in the Field in Potatoes, Turneps, Wheat, and Barley; a following Crop ſucceeds better after an equal Crop, conſiſting of a bare competent Number of ſtrong Plants, than after a Crop of thick weak ones, *cæteris paribus*.

Thus the hoed Crops, if well managed, conſiſting of fewer and ſtronger Plants than the ſown Crops of equal Produce, exhauſt the Ground leſs; whereby, and by the much (I had almoſt ſaid infinitely) greater Pulveration of the Soil, indifferent good Land may, for any thing I have yet ſeen to the contrary, produce profitable Crops always without Manure, or Change of *Species*, if the Soil be proper for it in reſpect of Heat and Moiſture; and alſo as Crops of ſome *Species*, by their living longer, by their

greater

All theſe Advantages will be loſt by thoſe Drillers, who do not overcome the unreaſonable Prejudices of the unexperienced, concerning the Width of Intervals.

In wide Intervals, we can raiſe a good Crop with leſs Labour, leſs Seed, no Dung, no Fallow, but not without a competent Quantity of Earth, which is the leaſt expenſive of any thing given to Corn; the Earth of a whole good Acre being but about the Tenth Part of the common Expence; and of indifferent Land, a Twentieth; and ſuch I count that of Five Shillings and Six-pence *per* Acre.

The Crop enjoys all the Earth; for betwixt the laſt Hoeing, and the Harveſt, there remains nothing but Space empty of Mould in the Middle of the Intervals.

'Tis an Objection, that great Part of thoſe wide Intervals muſt be loſt (*u*), becauſe the Wheat-roots do not

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greater Bulk, or different Conſtitution, exhauſt more than others, reſpect ought to be had to the Degree of Richneſs of the Soil, that is to produce each *Species:* The Sowing and the Hoeing Huſbandry differ ſo much both in Pulveration and Exhauſtion, that no good Argument can be drawn from the former againſt the latter: But tho' a too great Number of Plants be, upon many Accounts, very injurious to the Crop, yet 'tis beſt to have a competent Number; which yet needs not be ſo exact, but that we may expect a great Crop from Twenty, Forty, or Fifty Plants in a Yard of the treble Row, if well managed.

(*u*) They do reach through all the Mould (as ſhall be proved by-and-by); and yet may leave ſufficient Paſture behind; becauſe it is impoſſible for them to come into Contact with all the Mould in one Year; no more than when Ten Horſes are put into an Hundred Acres of good Paſture, their Mouths come into Contact with all the Graſs to eat it in one Summer, though they will go all over it, as the Vine-roots go all over the Soil of a Vineyard without exhauſting it all; becauſe thoſe Roots feed only ſuch a bare competent Quantity of Plants, which do not overſtock their Paſture.

The Superficies of the fibrous Roots of a proper Number of Wheat-plants bear a very ſmall Proportion to the Superficies of the fine Parts of the pulveriz'd Earth they feed on in theſe Intervals; for one cubical Foot of this Earth may, as is ſhewn in p.

not reach it; but as we generally turn the Mould towards the Row at the laſt Hoeings, there is no Part of

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p. 29. have many thouſand Feet of internal Superficies: But this is in proportion to the Degree of its Pulveration; and that Degree may be ſuch as is ſufficient to maintain a competent Number of Wheat-plants, without over-exhauſting the vegetable Paſture, but not ſufficient to maintain thoſe, and a great Stock of Weeds beſides, without over-exhauſting it. And this was plainly ſeen in a Field of Wheat drilled on *Six-feet* Ridges, when the South Ends of ſome of the Ridges, and the North Ends of others, had their Partitions Hand-hoed, and cleanſed of Weeds, early in the Spring, the oppoſite Ends remaining full of a ſmall *Species* of Weeds, called *Crow-needles*, which ſo exhauſted the whole Intervals of the weedy Part of the Ridges, that the next Year the whole Field being drilled again with Wheat, exactly in the Middle of the laſt Intervals, the following Crop very plainly diſtinguiſhed how far each Ridge had its Partitions made clean of thoſe ſmall Weeds in the Spring, from the other End where the Weeds remained till full-grown; the Crop of the former was twice as good as that of the latter, even where both were cleanſed of Weeds the next *Spring*. This Crop ſtanding only upon that Part of the Mould, which was fartheſt from the Rows of the precedent Crop, proves that the Roots, both of the Wheat and Weeds, did enter all the Earth of the former Intervals.

It was alſo obſervable, that where the Partitions of Two of the Six-feet Ridges had been in the precedent Year cleanſed of Weeds, and thoſe of the adjoining Ridges on each Side of them not cleanſed, the Row that was the next Year planted exactly in the Middle of the Interval between thoſe two Ridges, was perceivably better than either of the Two Rows planted in the Intervals on the other Side of each of them: The Reaſon of which Difference muſt be, that the Middle of the Interval, that was between the Two cleanſed Ridges, was fed on by the Wheat only, and by no Weeds; but the other Two Intervals were fed on by the Wheat on one Side, and by both the Wheat and Weeds on the other Side of each.

There were, in the ſame Field, ſeveral Ridges together, that had the Ends of their Rows of Wheat plowed out by the Hoe-plough, and their other Ends cleanſed of Weeds: This was done on purpoſe, to ſee what Effect a Fallow would have on the next Crop, which was indeed extraordinary; for theſe fallowed Ends of the Ridges, being Horſe-ho'd in the Summer, as the other Ends were, and the Intervals of them made into Ridges, the following Year produced the largeſt Crop of all; this Crop was received in 1734.

Theſe

of it above Two Feet diſtant from even the middle Row, and Seventeen Inches from either of the outſide Rows.

And I have plainly prov'd, that the Roots of Cone-wheat have reach'd Mould at Two Feet Diſtance, after paſſing through another Row at a Foot Diſtance from it, the Plants being then but Eighteen Inches high, and but half-grown.

Farmers do not grudge to beſtow Three or Four Pounds in the Buying and Carriage of Dung for an Acre; but think themſelves undone, if they afford an extraordinary Eighteen-penyworth of Earth to the wide Intervals of an Acre; not conſidering that Earth is not only the beſt, but alſo the cheapeſt Entertain-

These ſeveral different Managements performed in this Field, ſhewed by the different Succeſs of the Crops in each Sort, what ought to be done, and which is the beſt Sort of Management.

This Field indeed is ſome of my beſt Land; and by all the Experiments I have ſeen on it, I do not find but that, by the beſt Management, never omitted in any Year, it might produce good annual Crops of Wheat always, without Aſſiſtance of Dung or Fallow; but it would be very difficult for me to get Hands to do this to the greateſt Perfection, unleſs I were able conſtantly to attend them.

The whole pulverized Earth of the Interval being pretty equally fed on by the former Crop, 'tis no great Matter in what Part of it the following Crop is drill'd: I never drill it but on the Middle of the laſt Year's Interval, becauſe there is the Trench whereon the next Year's Ridge is made with the greateſt Conveniency: But there may be ſome Reaſon to ſuſpect, that the Plants of the Rows exhauſt more Nouriſhment from that Earth of the Intervals which is fartheſt from their Bodies, than from that which is neareſt to them: Since their fibrous Roots, at the greateſt Diſtance from the Rows, are moſt numerous, *&c.* by theſe the Plants, when they are at their greateſt Bulk, are chiefly maintained.

It muſt be *noted*, that the above Experiments would not have been a full Proof, if Weeds had been ſuffered to grow in the Partitions of the Ends of thoſe Ridges, in the Year wherein the Difference appeared. It may alſo be *noted*, that a Mixture and Variety of bad Huſbandry are uſeful for a Diſcovery of the *Theory* and *Practice* of good Huſbandry.

ment that can be given to Plants; for at Five Shillings and Six-pence Rent, the whole Earth belonging to each of our Rows coſts only Six-pence, *i. e.* a Peny for a Foot broad, and Six hundred and Sixty Feet long; that being the Sixty-ſixth Part of an Acre(*x*).

And if for conſtant annual Wheat-crops you make fewer than Eleven Rows on Four Perches Breadth, you will always increaſe the Expence of Hoeing; becauſe then Two Furrows will not Hoe One of thoſe Intervals, and you will alſo thereby leſſen the Crops, but improve the Land more: And if you increaſe that Number of Rows, you will thereby increaſe every Expence; for there muſt be Two Furrows to hoe a narrow Interval, and an Increaſe of the Quantity of Seed, and the Labour in uncovering, weeding, and reaping; and alſo you will leſs improve the Land, and leſſen the Crops after the Firſt Year.

If the Intervals are narrower in deep Land, tho' there might be Mould enough in them, yet there would not be Room to pulverize it.

If narrower in ſhallow Land, tho' there were Room, yet there would not be Mould enough in them to be pulveriz'd.

The Horſe-hoe, well apply'd, doth ſupply the Uſe of Dung and Fallow; but it cannot ſupply the Uſe of Earth, tho' it can infinitely increaſe the vegetable Paſture of it, by pulverizing it, where it is in a reaſonable Quantity: Yet if the Intervals be ſo narrow, that near all the Earth of them goes to make the Partitions raiſed at the Top of the Ridges, there will be ſo little to be pulveriz'd, that you muſt return to Fallowing,

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(*x*) But the Vulgar compute this Expence of a Foot Breadth of Ground, not only as of the Rent, as they ought, but as an Eleventh Part of their own uſual Charges added to the Rent.

And there is Land enough in *England* to be had, at the Rent of Five Shillings and Six-pence the Acre, that is very proper for Wheat in the Hoeing-Huſbandry.

and to the Dung-cart, and to all the old exorbitant Charges (*y*).

Eight Acres, Part of a Ground of Twenty Acres, drill'd with Intervals of Three Feet and an half, brought a good Crop; but the Second Year, not being ho'd, the Crop was poor; and the Third Crop made that Land ſo foul and turfy, that 'twas forc'd to lie for a Fallow, there being no way to bring it into Tilth without a Summer-plowing (*z*), when the reſt of the ſame Piece, in wider Intervals, being conſtantly ho'd, continu'd in good Tilth, and never fail'd to yield a good Crop, without miſſing one Year.

In another Field, there is now a Sixth Crop of Wheat, in wide Intervals, very promiſing, tho' this Ground has had no ſort of Dung to any of theſe Crops, or in ſeveral Years before them: The laſt Year's Crop was the Fifth, and was the beſt of the Five, tho' a Yard of the Row yielded but Eighteen Ounces and Three Quarters; and the Third Crop yielded Twenty Ounces Weight (*a*) of clean Wheat in

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(*y*) The Objections againſt theſe wide Intervals are only for ſaving a Penyworth or Two of Earth in each Row, or a few Groats-worth of it in an Acre; by ſaving of which Earth they may loſe, in the preſent and ſucceeding Crops, more Pounds.

(*z*) This Narrowneſs of the Intervals, if the Damage of it be rightly computed, would amount to half the Inheritance of the Land; and was occaſioned by the Wilfulneſs of my Bailiff, who, drilling it upon the Level, ordered the Horſe to be guided half a Yard within the Mark, becauſe he fanſied the Intervals would be too wide, if he follow'd my Directions.

(*a*) Wheat, before Harveſt, ſtanding in Rows with wide Intervals betwixt them, may not ſeem, to the Eye, to equal a Crop of half the Bigneſs diſpers'd all over the Land, when ſown in the common Manner; and yet there is more Deceit in the Appearance of thoſe different Crops, whilſt they are young, and in Graſs: We ſhould therefore not judge of them then by our Imagination, but as we do of the Sun and Moon nigh the Horizon, *viz.* by our Reaſon.

in the ſame Spot; but 'twas becauſe the Spot where the Twenty grew, was then a little higher than the reſt, which in Two Years became more equal; and the thin Land was more deficient in that Third Crop, than the thick Land exceeded the thin in the Fifth Crop.

In the thick the Hoe-plough went deeper, and conſequently raiſed more Paſture there; but then it went the ſhallower in the thin; and when the Land became of a more equal Depth the Fifth Year, the Plough and the Hoe-plough went deeper, all the Piece being taken together; for the Crop could be but in proportion to the different Paſture, allowing ſomewhat for the more or leſs Seaſonableneſs of the Year.

The Soil, in this our Caſe, cannot be ſupply'd in Subſtance, but from the Atmoſphere. The Earth which the Rain brings can do it alone, if it fall in great Quantity; for by Water, 'tis plain, the Earth which nouriſh'd *Helmont*'s Tree was ſupply'd; for the Tin-cover of the Box wherein it ſtood, prevented the Dews from entering.

Dews muſt add very much to the Land, thus continually till'd and ho'd; for they are more heavily charged with terreſtrial Matter than Rain is, which appears from their forcing a Deſcent through the Air, when 'tis ſtrong enough to buoy up the Clouds from falling into Rain: And Dew, when kept in a Veſſel long enough to putrefy, leaves a greater Quantity of black Matter at the Bottom of the

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Imagination often deceives us by Arguments falſe or precarious; but Reaſon leads us to Demonſtration, by Weights and Meaſures: Yet this Prejudice will vaniſh at Harveſt before weighing; for then all thoſe wide Intervals that were bare, will be cover'd with large Ears interfering to hide them quite, and make a finer Appearance than a ſown Crop. But 'tis obſerv'd, that the Cone-wheat makes the fineſt Shew, when you look on it length-ways of the Rows, both at Harveſt, and a conſiderable time before Harveſt.

Veſſel, than Rain-water does in a Veſſel of the ſame Bigneſs, fill'd with it till putrefy'd.

Dews at Land, I ſuppoſe, are firſt exhal'd from Rivers, and moiſt Lands, and from the Expirations of Vegetables; moſt of the Dew which falls on it is exhal'd from untill'd Land; but moſt of that which falls on well till'd or well ho'd Land, remains therein unexhal'd; ſo that the untill'd Ground helps, by that means, to enrich and augment the till'd: For if an Acre be till'd for Two Years together without ſowing, it will become richer by that Tillage, than by lying unplow'd Four Years, which may be eaſily prov'd by Experience (*b*).

But then, as to Rain, the Sea being larger than all the Land (and its Waters, by their Motion, becoming replete with terreſtrial Matter), 'tis not unlikely, that more Vapour is raiſed from One Acre of Sea, than from One hundred Acres of Land.

Some have been ſo curious as to compute the Quantity of Rain, that falls yearly in ſome Places in *England*, by a Contrivance of a Veſſel to receive it; and 'tis found, in one of the drieſt Places, far from the Sea, to be Fourteen Inches deep, in the Compaſs of a Year; in ſome Places much more; *viz.* at *Paris*, Nineteen Inches; in *Lancaſhire*, Mr. *Townley* found, by a long-continued Series of Obſervations, that there falls above Forty Inches of Water in a Year's time.

Could we as eaſily compute the true Quantity of Earth in Rain-water, as the Quantity of Water is computed, we might perhaps find it to anſwer the Quantity of Earth taken off from our ho'd Soil annually by the Wheat.

But if Land ſown with Wheat be not ho'd, its Surface is ſoon incruſtate; and then much of this Water, with its Contents, runs off, and returns to

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(*b*) *Non igitur Fatigatione, quemadmodum plurimi crediderunt,* nec Senio, *ſed noſtra ſcilicet* Inertia, *minus benigne nobis Arva reſpondent.* Colum. *lib.* xi. *cap.* 1.

the Sea, without entering that Ground; and in Summer a great deal of what remains is exhal'd by the Sun, and rais'd by the Wind, both in Summer and Winter.

Some there are who think it a fatal Objection, that the more an Interval is ho'd, the more Weeds will grow in it; and that the Hoe can produce, or (as they ſay) breed in it as many Weeds in One Summer, as would have come thereon in Ten Years by the old Huſbandry. But by this Objection they only maintain, that the Hoe can deſtroy as many Weeds in One Summer, as the old Huſbandry can in Ten Years.

And they might add, that ſince all Weeds that grow where the Hoe comes, are kill'd before they ſeed, and that few of thoſe which grow in the old Huſbandry, are kill'd (*c*) before their Seed be ripe and ſhed; theſe Objectors will be forc'd to allow, that our Huſbandry will leſſen a Stock of Weeds more in one Summer, than theirs can do to the World's End; unleſs they believe the equivocal Generation of Weeds, than which Opinion nothing can be more abſurd.

Some object againſt my Method of (*d*) weighing a Yard, or a Perch in Length of a Row, ſaying, this does not determine the Produce of a whole Field.

I an-

(*c*) Weeds cannot be kill'd before they grow, but will lie dormant, as they do in our Partitions, and in their ſown Land; and while Seeds are in the Ground, they are always ready to grow at the firſt Opportunity, and will certainly break out at one time or other; ſo that preventing their coming, is only like healing up a Wound before it be cured.

(*d*) I did not weigh this Yard, as different from the other Yards round about it, for I had much Difficulty to determine which Row I ſhould chuſe it in; when I was going to cut in one Row, it ſtill ſeemed that another was better, and I queſtion whether I did chuſe the beſt at laſt.

Note, Whereas I often mention the Wheat of this Field to be without Dung or Fallow, it muſt be underſtood of that Part of the Field wherein my *Weighings* and other Trials were made;

becauſe

I anſwer, that they judge right, if the Produce of the whole Field be not of equal Goodneſs; but if it be not, it muſt be becauſe one Part of the Field is richer, or differently managed from the other Part: For the ſame Cauſes that produce Twenty Ounces of clean Wheat upon one Yard, muſt produc the ſame Quantity upon every Yard, of a Million of Acres.

When the Crop of half a Field is ſpoil'd by Sheep, not ho'd at all, or improperly, it would be ridiculous to compute the whole Field together for an Experiment: We might indeed weigh the pooreſt, to prove the Difference of the one from the other, to try (as they ſometimes ſeem to do) how poor a Crop we can raiſe; but my Deſign was, to try how good a Crop I could raiſe with a Tenth Part of the common Expence.

And I have often weighed the Produce of the ſame Quantity of Ground (*e*), of all Sorts of ſown Wheat, both the beſt and the worſt; but never have found any of the ſown equal to the beſt of my drill'd. Indeed we have none of the richeſt Land (*f*) in our

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becauſe there was a ſmall Part once fallowed Eight or Nine Years ago, and a little Dung laid on another Part about the laſt *Michaelmas*, after the Crop of Oats was taken off. But this being a Year in which Dung is obſerved to have little or no Effect on *ſown* Wheat (my Dung being weak and laid thin), 'tis the ſame here; for thoſe Rows which are in the dunged Part, can hardly be diſtinguiſhed from the reſt of the Rows which had not been dunged: And yet the Ends of the Rows which were cleanſed of Weeds, are very diſtinguiſhable by the Colour of the Wheat, though ſome are the Third, and ſome the Fourth Crop ſince the Difference was made; and the *whole* Rows managed alike every Year, from that time to this; ſo that *here* Un-exhauſtion is more effectual than Dung. This is certain, that neither Dung nor Fallow hath been near the Part wherein my Experiments were made.

(*e*) I allow Two ſquare Yards of their Crops to One Yard in Length of my Treble Row.

(*f*) I am ſorry that this Farm, whereon I have practis'd Horſe-hoeing, being ſituate on an Hill, that conſiſts of Chalk on one Side, and Heath-ground on the other, has been uſually noted for the pooreſt and ſhalloweſt Soil in the Neighbourhood.

Country within my Reach, that being not above One Mile.

As a Yard in Length of my treble Row of the Third ſucceſſive Crop of Wheat, without Dung or Fallow, produced Twenty Ounces of Wheat; which, allowing Six Feet to the Ridge, is about Six Quarters *(a)* to an Acre; and, allowing Seven Inches to each Partition, and Two Inches on each Outſide, is in all Eighteen Inches of Ground to each treble Row, and but juſt One-fourth Part of the Ridge. Now, if, in the old Huſbandry, the Crop was as good all over the Ground, as it was in theſe Eighteen Inches of the treble Row, they muſt have Twenty-four Quarters to an Acre; but let them dung whilſt they can, they will ſcarce raiſe Twenty-four Gallons of Wheat the Third Year, on an Acre of Land of equal Goodneſs; and let them leave out their Dung, and add no more Tillage in lieu of it, and I believe they will not expect Three Quarters to an Acre, in all the Three Years put together.

The mean Price of Wheat, betwixt Dear and Cheap, is reckon'd Five Shillings a Buſhel *(b)*; and there-

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(*a*) Eight Buſhels make a Quarter.

(*b*) 'Tis commonly ſaid, that a Farmer cannot thrive, who for want of Money is obliged to ſell his Wheat under Five Shillings a Buſhel; but if he will ſell it dear, he muſt keep it when 'tis cheap: And his Way of keeping it is in the Straw, uſing his beſt Contrivances to preſerve it from the Mice.

The moſt ſecure Way of keeping a great Quantity of Wheat, that ever I heard of, is by drying it. When I lived in *Oxfordſhire*, one of my neareſt Neighbours was very expert in this, having practis'd it for great Part of his Life: When Wheat was under Three Shillings a Buſhel, he bought in the Markets as much of the middle ſort of Wheat as his Money would reach to purchaſe: He has often told me, that his Method was to dry it upon an Hair-cloth, in a Malt-kiln, with no other Fuel than clean Wheat-Straw; never ſuffering it to have any ſtronger Heat than that of the Sun. The longeſt time he ever let it remain in this Heat was Twelve Hours, and the ſhorteſt time about Four Hours; the damper the Wheat was, and the longer intended to be kept, the more therefore an Acre that would produce every Year, without any Expence, Eight Buſhels, wou'd be thought

more Drying it requires: But how to diſtinguiſh nicely the Degrees of Dampneſs, and the Number of Hours proper for its Continuance upon the Kiln, he ſaid was an Art impoſſible to be learnt by any other Means than by Practice. About Three or Four and Twenty Years ago, Wheat being at Twelve Shillings a Buſhel, he had in his Granaries, as I was informed, Five thouſand Quarters of dry'd Wheat; none of which coſt him above Three Shillings a Buſhel.

This dry'd Wheat was eſteemed by the *London* Bakers to work better than any new Wheat that the Markets afforded. His Speculation, which put him upon this Project, was, that 'twas only the ſuperfluous Moiſture of the Grain that caus'd its Corruption, and made it liable to be eaten by the Wevil; and that when this Moiſture was dry'd out, it might be kept ſweet and good for many Years; and that the Effect of all Heat of the ſame Degree was the ſame, whether of the Straw, or of the Sun.

As a Proof, he would ſhew, that every Grain of his Wheat would grow after being kept Seven Years.

He was a moſt ſincere honeſt Yeoman, who from a ſmall Subſtance he began with, left behind him about Forty thouſand Pounds; the greateſt Part whereof was acquired by this Drying Method.

For the Hand-hoeing they uſe Hoes of Four Inches Breadth, very thin, and well ſteeled: Their Thinneſs keeps them from wearing to a thick Edge, and prevents the Neceſſity of often grinding them. Such Hoes are in Uſe with ſome Gardeners near *London*. They need not be afraid of drawing theſe little Hoes acroſs the Rows of young Wheat to take out the few Weeds that come therein at the early Hoeing; for whilſt the Wheat-plants are ſmall, it may be an Advantage to cut out ſome of the weakeſt, as they do of Turneps; for I perceive there are oftener too many Plants than too few. But the thing that cauſes the greateſt Trouble in cleanſing the Rows, is when the Seed is foul (*i. e.* full of Seeds of Weeds): Therefore I cleanſe my Seed-wheat by drawing it on a Cloth on a Table, which makes it perfectly clean.

This Hand-hoeing ſhould be performed about the End of *March*, or Beginning of *April*, before the Wheat is ſpindled (*i. e.* run up to Stalks); and if the Weather be dry enough, you may go lengthways of the Ridges with a very light Roller to break the Clods of the Partitions, whereby the Hoe will work the better.

If there ſhould afterwards more Weeds come up, they muſt not be ſuffered to ripen; and then the Soil will be every Year freer from Weeds.

thought an extraordinary profitable Acre; but yet a drill'd Acre, that produces Sixteen Buſhels of Wheat,

This Hand-hoeing of the Rows ſhould be done at the proper time, though it happen, by late Planting, that the Horſe-hoe has not gone before it; for it may be, that the Weather has kept out the Horſe-hoe; and the Earth may not be dry deep enough in the Intervals for the Hoe-plough, but deep enough in the Partitions for the Hand-hoe.

And the Expence of this Hand-work on the Rows would be well anſwered, though there ſhould not be one Weed in them; and ſo it would be, if a ſecond Hand-hoeing were beſtowed on the Partitions of every Crop of Wheat not ſuſpected of being too luxuriant.

If after the laſt Horſe-hoeing there ſhould be occaſion for another Hoeing of the Intervals, where the Narrowneſs of them, and the Leaning of tall Wheat, make it difficult or dangerous to be performed by the Hoe-plough; a ſlight ſhallow Hoeing may be performed therein by the Hand-hoe with Eaſe and Safety, at a very ſmall Expence, which would be more than doubly repaid in the following Crops.

IF any one doubts of the Efficacy of thus managing Wheat, it can't coſt much to make proper Trials. But then Care muſt be taken, that the Trials be proper. I do not adviſe any one to be at the Expence of my Inſtruments for that Purpoſe, but to imitate them in pulverizing, and all other directed Operations by the Spade and common Hoes. His Ridges of Experiment need be no longer than Six Feet. Inſtead of a Drill, make uſe of a triangular Piece of Wood, Seven Feet long, and Four or Five Inches thick, with one Edge of which make Chanels, and place the Seed regularly even into them by Hand, and cover it with the ſame Piece of Wood; but if the Earth be ſo wet, as to cling to the Piece, then make uſe of it only as a Ruler, whereby to make the Chanels ſtrait with a Stick.

Let ſome of the Ridges have double Rows, others treble; and let ſome have treble Rows half-way, and leave out the middle Row in the other Half, to ſhew whether the double Row or the treble Row produce a better Crop.

Then for the Firſt time of Hoeing, the Spade muſt work with its Back towards the Row. The Second time, in turning the Earth to the Row, the Spade's Face muſt be towards it. Theſe Two, and ſeveral other Hoeings ſhould be deep; but when the Roots are large (and the Hoeing is near the Plants), the Spade muſt go ſhallow; and neither the Face nor the Back of it muſt

Wheat, with the Expence of Ten or Fifteen Shillings, is above a Third Part more profitable.

I don't

be towards the Row, except when the Earth is turned towards it; and then the Face muſt be always towards it; but for the reſt of the laſt Hoeings, the Spade ſhould work with its Face towards one or other of the Ends of the Intervals, that the fewer of the Roots may be cut off, and the more of them removed, and covered again. Let the Spits be thin for the better pulverizing of the Mould. The Hand-hoe will ſometimes be uſeful in the Intervals, as well as in the Partitions.

Four or Five Perches of Land may ſuffice for making proper Trials.

The Expence of this will be little, though perhaps Ten times more than that which is done by the proper Inſtruments for the ſame Proportion of Land.

But I muſt give this Caution, that no Part of it be done out of the Reach of the Maſter's Eye; for if it ſhould, he may expect to be diſappointed.

The richer the Land, the thinner it muſt be planted to prevent the lodging of Corn.

The Maſter ought to compute the Quantity of Seed, due to each Perch, at the Rate of Five or Six Gallons to an Acre, by Weighing, *&c.* as I have ſhewn in my Eſſay.

I cannot commend more than Two Partitions in a Row, or more than One, when the Intervals are narrow; becauſe the broader the Row is, the more Earth will remain unpulverized, under the Partitions; too much of which Earth being whole, will diſappoint, at leaſt, one of the Differences mentioned in my xviith Chapter.

Indifferent Land I think moſt proper whereon to make the Experiment, and the moſt improper for Corn is barren Land, as the beſt brings the largeſt Crops.

To aſcertain the Quantity of the Crop, take a Yard in the Middle of a Ridge, and weigh its Produce.

Every Year leave one Interval unho'd, to prove the Difference of that Side of a double or treble Row next to it, from the other Side next to the ho'd Interval.

But it muſt be *noted*, that the Spade doth not always pulverize ſo much as the Plough, or Hoe-plough; therefore there may be occaſion for more Diggings than there would be of Horſe-hoeings.

One of the Obſervations that put me upon Trials of wide Intervals, and Horſe-work for Corn, was the following; *viz.* One Half of a pooriſh Field was ſown with Barley; the other Half drilled with Turneps, the Rows Thirty Inches aſunder, at the proper Seaſon, and twice hoed with a ſort of Horſe-hoe contrived for that Purpoſe (but nothing like that I have deſcribed); the Drill, beginning next to the Barley, left an Interval of the ſame (30 Inches) Breadth between the Firſt Row of Turneps and the Barley, which, being ſown on large Furrows, came up in a ſort of Rows, as is common for Barley to come when ſown on ſuch wide Furrows. This Interval between the Barley and the Turneps had the ſame Hoeings as the reſt, and had this Effect on the broad Row of Barley next to it; *viz.* Each Plant had many Stalks; it was of a very deep-flouriſhing Colour, grew high, the Ears very long, and, in all reſpects, the Barley was as good as if it had been produced by the richeſt Land. The next Row of Barley had ſome little Benefit on the Side next to the ſtrong Row; but all the reſt of the Barley, either by the too late Sowing of it, the Poverty of the Soil (not being in any manner dunged), or elſe by the Coldneſs of the Land, or Coldneſs of the Summer, or by all of theſe Cauſes, though pretty free from Weeds, was exceeding poor, yellow, low, thin, and the Ears were very ſhort and ſmall.

I intended to have taken the exact Difference there was between the Produce of this outſide Row, and one of thoſe that ſtood out of the Reach of the hoed Interval: But I was diſappointed by my Neighbour's Herd of Cows, that in the Night broke in juſt before Harveſt, and eat off almoſt all the Ears of the rich Row, doing very little Damage to the reſt, except by treading it. It muſt be from the different Taſtes, the one being ſweet, and the other bitter, that they make their Election to eat the one, and refuſe the other.

This accidental Obſervation was ſufficient to demonſtrate the Efficacy of deep Hoeing, which I look upon as ſynonymous to Horſe-hoeing.

I immediately ſet about contriving my limber'd Hoe, finding all other ſorts inſufficient for the Exactneſs required in this hoeing Operation: Thoſe drawn in any other manner, when they went too far from the Row, and the Holder went to lift the Plough nearer, it would fly back again, like the Sally of a Bell, and go at no Certainty, not being ſubject to the Guidance of the Holder, as the limber Hoe-plough is. The *Michaelmas* following I began my preſent Horſe-hoeing Scheme; which has never yet deceived my Expectations, when performed according to the Directions I have given my Readers. And the Practice of this Scheme proves the Advantage of deep Hoeing, by the Ends of the Ridges and Intervals; for there, whilſt the drawing Cattle go on the Headland that is higher, the Furrows are ſhallower, and the Corn of the Rows is always there viſibly poorer in proportion to that Shallowneſs.

Another Proof of the Difference there is between deep Hoeing and ſhallow, is in the Garden, where a ſquare Perch of Cabbages, the Rows of which are Three Feet aſunder; the middle Row of them having the Intervals on each Side of it deeply and well dug by the Spade at the ſame proper time, when the reſt of the Intervals are Hand-hoed; this middle Row will ſhew the Difference of thoſe Two Operations: But in this muſt be obſerved what I have here before-mentioned, of turning the Back of the Spade to the Plants, to avoid the total removing them, eſpecially in very dry Weather.

This Experiment hath been tried, and always ſucceeds with every one that has made the Trials.

But before any one makes his Trials of my Field-ſcheme, I would adviſe him to be Maſter of the Treatiſe, by making an *Index* himſelf to it: This will both direct him in his Proceedings, and ſhew him the Raſhneſs of thoſe, who go into the Practice of my Huſbandry, without the neceſſary Preparation; for they that do ſo now, ſeem to act as raſhly, as they that went into it before the Treatiſe was publiſhed. 'Tis reaſonable to preſume, that ſuch their Practice muſt be either different from, or contrary to mine.

This *Index* may be alſo uſeful for diſcovering Pretenders by an Examination, without which, Gentlemen are liable to be impoſed on by them, as I am afraid too many have been; for amongſt all thoſe who have undertaken the Management of my Scheme for Noblemen, or others, I declare I do not know one Perſon that ſufficiently underſtands it: There may be ſome who have ſeen, or perhaps performed, ſome of the mechanical Part; but I don't think it can be properly performed without a thorough Knowlege of the Principles, which cannot be expected of ſuch illiterate Perſons; and yet is neceſſary for the proper Applications in different Caſes, which cannot be diſtinguiſhed by Pretenders: Therefore, until the Scheme becomes common, the Management muſt be under the Direction of the Maſter himſelf, or of one who has paſt his Examination, and is faithful.

To the above Trials I here add the following, together with ſome Alterations of the former.

Gentlemen who can get the *Smyrna* Wheat, I adviſe to make Trials of it in ſingle Rows, of between 17 and 18 to an Acre, in this Method; there being no Partitions, the Intervals will be of the ſame Width as in the Ridges of 14 to an Acre, that have Partitions of Ten Inches. Thus almoſt all the Earth of the Ridges may be pulveriz'd by the Hoe-plough in the Field, or by the Spade in this Trial; and very little Hand-work will be neceſſary for cleanſing out the Weeds that come in the Rows, and on each ſide of them. The Land will be the fitter for a ſucceeding Crop of Wheat with leſs Harrowing. But this muſt be obſerv'd, that, in regard to hard Froſts in Winter, and very dry Weather in Summer, the alternate Hoeing deſcrib'd in the Chapter of Turneps may be proper; leſt the little Earth that may be left for the Row to ſtand on, when the Furrows are turn'd from both Sides of it, ſhould not be ſufficient to ſecure the Roots from the Injuries that may happen to them by being expoſed either to Froſt or Drought on both Sides of the Row at the ſame time.

In the Field, when the Ridges are all of an equal Breadth, the beſt way is to plant Two of the ſingle Rows at once, by ſetting the Two Beams of the Drill at the ſame Diſtance aſunder, as each of the Ridges is broad; and the Beaſt that draws it muſt go in the Middle of the Interval, planting a Row on each Side of it; but if the Ridges are very unequal, the Beaſt (a little Horſe is beſt) that draws the Drill muſt go on the Top of a Ridge, planting one Row thereon; and the Drill for this Purpoſe is the ſame as the Turnep-drill, except that the Beam-ſhare, Seed-box, and Spindle, are the ſame as thoſe of the Wheat-drill; and 'tis but to take off from the Wheat-drill one of its Beams, and place it in the room of the Beam of the Turnep-drill, and placing the Croſs-piece of the Turnep-beam (ſee Plate 5.) on this Beam, and alſo a ſhort Wheat-hopper to be drawn by the Turnep-ſtandards, ſetting the Wheels near enough together; *i. e.* as near as the Wheels of the Wheat-drill are, I mean thoſe which plant Two Rows.

Two Gallons of *Smyrna* Wheat I judge will be Seed ſufficient for an Acre, eſpecially if planted early.

Planting one Row upon a Ridge, I think is the moſt advantageous Method of all; but, not being able to get any *Smyrna* Wheat (tho' I have been often promiſed it), I have made no Trial of it; and I do not believe the Plants of any other ſort of Wheat are large enough for ſuch ſingle Rows.

I am not quite a Stranger to this Wheat; for I have ſeen the Product of it, both in the Garden, and in the Field, above Forty Years ago.

I am now making Trials, in order to know how much a ſingle Row of White-cone Wheat will exceed half a double one: For this Purpoſe, I cauſe one Row of the double, with the Partition, to be dug out with a Spade, in Part of every Field, Two or Three Yards in a Place: Theſe I intend ſhall be ho'd as the double Rows are; and where the Hoe-plough doth not reach, the Spade ſhall ſupply its Uſe.

I do not expect this ſingle Row will equal the double Row; but I am in no doubt but that it will produce more Grain than half a double Row.

I can't tell whether the ſort of Cone-wheat that ſends out little Branches on each ſide of the Ear, might not ſucceed tolerably well in ſingle Rows; for its Ear is, when well nouriſhed, larger than the Ear of the White-cone; tho' not near ſo large as that of the *Smyrna*.

Another Experiment I propoſe to be made as a Trial for the Satisfaction of ſuch ſceptical Gentlemen who may doubt the Truth

I don't know that I ever had an Acre yet, that was tolerably well manag'd in this Manner, but what produc'd much more.

CHAP.

Truth of what I have related in p. 27, 28. concerning the wonderful Effect of deep Hoeing. In a Field of very poor old decay'd St. Foin, let Two or Three Perches be hedg'd in, in a ſquare Piece, and Two, Three, or more Intervals, of Three or Four Feet wide each, be well pulveriz'd by the Spade, leaving between every Two of them, Two or Three Feet of the St. Foin unmoved. Begin this Work in Summer, and repeat the Hoeing pretty often, obſerving the Rules I have laid down for hoeing the Intervals of Wheat. Let not the Back of the Spade be turned towards the unmov'd St. Foin, from which it throws the Earth at the Firſt time of Hoeing; which is contrary to the Firſt Hoeing of Wheat with a Spade; becauſe there would otherwiſe be Danger of moving the Wheat-roots; but there is no Danger of moving the St. Foin Roots, unleſs you wholly dig them out: Therefore the beſt way for this Hoeing is to dig with the Back of the Spade towards one or the other End of the Interval: This cuts off the feweſt Roots, and covers the moſt of them, and may perhaps be ſometimes beſt for Wheat alſo. When the Earth is turn'd towards the St. Foin Rows, the Spade's Face will be towards them of courſe.

Be ſure to leave Four or more Feet untouch'd next to the Hedge that bounds the Piece, to the end that the Increaſe of the ho'd St. Foin may the more plainly appear by comparing its Plants with thoſe that are not hoed.

If the Plants are very thick, make them thinner on one ſide of an Interval; and, on the other ſide, let them remain thick. You will certainly find the thin Plants moſt wonderfully increaſed in a Year or two, and the thick ones in proportion; and alſo the natural Graſs, and all other Vegetables that grow near to the Intervals when they are well pulveriz'd. I am confident mine, thus manag'd by Ploughs, increas'd ſome to an Hundred, ſome to a Thouſand times the Size they were of before that Pulveration.

All the Methods I have here and elſewhere deſcrib'd for the Field, I adviſe to be tried in theſe few Perches for Experiments.

I think ſome of thoſe Ridges whereon one End is to be managed differently from the other End, ſhould be longer than Six Feet; elſe the Roots of the Wheat and Weeds may ſo mix, and draw Nouriſhment from one another in the Middle of the Ridge, that the Difference of the Managements may not ſo plainly be ſeen as when the Ridge is longer.

The few Perches of Land whereon any of the propos'd Experiments are to be made, ſhould be bounded in with dead Hedges;

and

CHAP. X.

Of SMUTTINESS.

SMUTTINESS is when the Grains of Wheat, inſtead of Flour, are full of a black, ſtinking Powder: 'Tis a Diſeaſe of Wheat, which I don't know is uſual any-where but in cold Northern Countries; for if it had been common in *Greece* or *Italy*, there would probably have been ſome Word to expreſs it by, in thoſe Languages, as well as there is for the Blight.

I take it to be cauſed by cold wet Summers; and I was confirm'd in this by ſeveral Plants of Wheat, taken up when they were in Graſs in the Spring, and plac'd in Troughs in my Chamber-window, with ſome of the Roots in Water. Theſe Wheat-plants ſent up ſeveral Ears each; but at Harveſt, every Grain was ſmutty; and I obſerv'd, none of the Ears ever ſent out any Bloſſom: This Smuttineſs could not be from any Moiſture that deſcended upon it, but from the Earth, which always kept very moiſt, as in the aforeſaid Mint Experiment. The Wheat-plants in the Field, from whence theſe were taken, brought very few ſmutty Grains, but brought much larger Ears than theſe.

Whatſoever the Cauſe (*d*) be, there are but Two Remedies propoſed; and thoſe are Brining, and Change of Seed.

Brining of Wheat, to cure or prevent Smuttineſs (as I have been credibly inform'd), was accidentally

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and ſhould not be ſituate within Three or Four Poles of a live Hedge or Tree.

The Three Inſtruments to be uſed in theſe unexpenſive Trials, are, the Spade, to ſupply the Uſe of the Plough and Hoe-plough; the Hand-hoe; and a Rake, inſtead of Harrows.

(*d*) The largeſt-grain'd, plump, fat Wheat, is more liable to Smuttineſs, than ſmall-grain'd thin Wheat.

diſcover'd about Seventy Years ago, in the following Manner; *viz.* A Ship-load of Wheat was ſunk near *Briſtol* in Autumn, and afterwards at Ebbs all taken up, after it had been ſoak'd in Sea-water; but it being unfit for making of Bread, a Farmer ſow'd ſome of it in a Field; and when it was found to grow very well, the whole Cargo was bought at a low Price by many Farmers, and all of it ſown in different Places. At the following Harveſt, all the Wheat in *England* happen'd to be ſmutty, except the Produce of this brined Seed, and that was all clean from Smuttineſs. This Accident has been ſufficient to juſtify the Practice of Brining ever ſince in all the adjacent Parts, and in moſt Places in *England.*

I knew Two Farmers, whoſe Farms lay intermix'd; they bought the ſame Seed together, from a very good Change of Land, and parted every Load betwixt them in the Field. The oldeſt Farmer believ'd Brining to be but a Fancy, and ſow'd his Seed unbrined; the other brined all his Part of Seed, and had not a ſmutty Ear in his Crop; but the old Farmer's Crop was very ſmutty.

Wheat for Drilling muſt have no other Brine, than what is made of pure Salt; for if there be any Brine of Meat amongſt it (*e*), the Greaſe will not ſuffer the Wheat to be dry enough to be drill'd.

If Seed-wheat be ſoaked in Urine, it will not grow; or if only ſprinkled with it, it will moſt of it die, unleſs planted preſently.

The moſt expeditious Way of brining Wheat for the Drill, is to make a very ſtrong Brine; and when the Wheat is laid on an Heap, ſprinkle or lave it therewith; then turn it with a Shovel, and lave on more Brine; turn it again with a Shovel, until, by many Repetitions of this, the Wheat be all equally wet.

(*e*) Urine alſo makes the Wheat ſo greaſy, that it will not be dry time enough to be drilled.

wet. Next, ſift on Quick-lime through a Sieve; turn the Wheat with a Shovel, and ſift on more Lime; repeat this Sifting and Turning many times, which will make it dry enough to be drill'd immediately; and this has been found ſufficient to preſerve uninfected Wheat from the Smut in a bad Year, the Seed being chang'd.

To dry it, we uſe (*f*) Quick-lime (that is, unſlack'd), which, beaten to Powder, and ſifted thereon, confines the Brine to the Surfaces of the Grains, and ſuffers none of it to be exhaled by the Air: But when Lime has been long ſlack'd, and is grown weak, 'tis unfit for this Purpoſe.

Smutty Seed-wheat, tho' brined, will produce a ſmutty Crop, unleſs the Year prove very favourable.

For 'tis to be known, that favourable Years will cure the Smut, as unkind ones will cauſe it: Elſe, before Brining was uſed, and the bad Years had cauſed all the Wheat in *England* to be ſmutty, they muſt have brought their Seed from Foreign Countries, or never have had any clean Wheat: Therefore 'tis certain, that kind Years will cure the Smut: 'Tis therefore to prevent the Injury of a bad Year, that we plant clean Seed, and well brined.

But of the Two Remedies againſt Smuttineſs, a proper Change of Seed ſome think the moſt certain.

A very worthy Gentleman aſſures me, that ſince he has found out a Place that affords a Change of Seed proper to his Land, which is for theſe Ten Years

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(*f*) But if this doth not afford Powder enough, the Pieces muſt be ſlacked immediately before uſing; for if the Lime lie long after it is ſlacked (eſpecially that made of Chalk), it will become weak, and loſe moſt of its drying Quality.

Some Farmers uſe only to boil the ſtrongeſt Quick-lime in Water, with which, inſtead of Brine, they ſprinkle their Wheat, affirming it to be as effectual as that for preventing the Smut: But this not being within the Compaſs of my own Experience, I am doubtful of it; yet I wiſh it may be found effectual, becauſe it would ſave Trouble to the Sower, and more to the Driller.

Years paſt, he never had a ſmutty Ear in any of his Crops (and he never brines nor limes it), tho' all other Wheat have been often ſmutty throughout his Neighbourhood every wet Year, tho' brined and limed. He ſays, the Perſon who furniſhes him with this Seed, is very curious in changing his Seed alſo every Year.

This gives a Suſpicion, that our drowned Wheat at *Briſtol* might poſſibly be Foreign; and then might not have been ſmutty the next Year, tho' it had not been ſoak'd in the Sea-water.

The Wheat ſown by the Two Farmers aforemention'd might be from a good Change of Land, but the Seed not changed the precedent Year; and then it might be no more infected, than what the Brine and Lime did cure.

To know what Changes are beſt to prevent Smuttineſs of Wheat, we muſt conſult the moſt Experienc'd; and they tell us, that the ſtrong Clay Land is beſt to be ſent to for Seed-wheat, whatever ſort of Land it be to be ſow'd upon; a White-clay is a good Change for a Red-clay, and a Red for a White. That from any ſtrong Land is better than from a light Land; and the old Rhyme is, that Sand is a Change for no Land. But from whatever Land the Seed be taken, if it was not changed the preceding Year, it may poſſibly be infected; and then there may be Danger, tho' we have it immediately from never ſo proper a Soil.

The ſtrongeſt Objection that has been yet made againſt conſtant annual Crops of Wheat, is, that thoſe Grains of the precedent Crop which happen to ſhed, and grow in the following Crop, will be in Danger of Smuttineſs, for want of changing thoſe individual Seeds.

All I can ſay in Anſwer is, that during theſe Five Years, which is all the time I have had theſe annual Crops, this objected Inconvenience never has happen'd to me, even when a precedent Crop has been ſmutty.

The Reaſon I take to be, that a Crop very early planted is not ſo apt to be ſmutty; and if it be not planted early, the Grains that are ſhed grow, and are kill'd before, or at the time of planting the next Crop. This ſaves a Crop following a ſmutty one (which is always occaſion'd by bad Seed, or bad Ordering); and when the former Crop was planted with good Seed well order'd, the ſhatter'd Grains of that may produce clean Wheat the Second Year; and 'tis very unlikely, that any Breed of theſe Grains ſhould remain to grow in the Crop the Third Year.

CHAP. XI.

Of BLIGHT.

WHEAT is blighted at Two Seaſons; Firſt, when in the Bloſſom; and then its Generation is prevented, and many of the Huſks are empty in the Ear, the Grains not being impregnated.

Secondly, Wheat is blighted, when the Grains are brought to the time of their Maturity, but are light, and of little Value for making of Bread; becauſe they are not well fill'd with Flour.

The Firſt cannot happen in *England* by the Froſt, becauſe the Winters do not ſuffer it to grow ſo much, as to come into Bloſſom before the Month of *June*; but they are long continual Rains that rot or chill the Bloſſoms, and prevent their Fertility. Yet this is what ſeldom happens to any great degree. Wheat that grows in open Fields has ſome Advantage from the Wind, that diſlodges the Water ſooner from the Ears, than it can do in ſheltry Places; and Lammas Wheat does not hold the Drops of Rain ſo long as the Bearded (or Cone) Wheat, which receiv'd very great Damage by this ſort of Blight in the Year 1725. the like never having been heard of before.

The Second ſort of Blight, *viz.* from light Ears, is that which is moſt frequent, and more general: This brings the greateſt Scarcity of Wheat. The Cauſe is plainly want of Nouriſhment to perfect the Grain, by whatever means that Want is occaſion'd.

Several Accidents kill the Plants, or injure their Health, and then the Grains are not fill'd; as Lightning, the Effects whereof may be obſerv'd by the blackiſh Spots and Patches in Fields of Wheat, eſpecially in ſuch Years as have more of it than uſual. Againſt this there is no Defence.

The other Cauſes of the Blight, which are moſt general, and do the moſt Damage, may, in ſome meaſure, be prevented.

One Cauſe is the lodging or falling of Corn; for then the Stalks are broken near the Ground, whereby many of the Veſſels are ſo preſs'd, that the Juices cannot paſs them; and then the free Circulation is hinder'd; the Chyle cannot mount in ſufficient Quantity to be purify'd, and turn'd into Sap; the Defect whereof makes the Plants become languid, and only juſt able to live; they have Strength enough to linger on to the time of their Period, as in very old Age, but not to bring their Fruit, which is the Grain, to its natural Bulk, nor to fill it with Flour; and the ſooner the Stalks fall, the leſs and thinner the Grain will be.

Hence it often happens, that when Tillage, Dung, and good Land have brought a Crop of Wheat, that in the Months of *April* and *May* promiſe to yield the Owner Five or Six Quarters on an Acre, then in *June* it falls down, and ſcarce affords Five or Six Buſhels; and that perhaps is ſo thin and lank, that the Expence of reaping and threſhing it may overbalance its Value.

That the falling down of Wheat does cauſe the Ruin of the Crop, is well known; but what cauſes it to fall, is not ſo plain.

And, without knowing the true Cauſes, 'tis not likely that a Remedy ſhould be found againſt the Diſeaſe.

I take this Weakneſs of the Stalks, which occaſions their falling, to proceed from want of Nouriſhment, want of Air, want of the Sun's Rays, or of all Three.

One Argument, that it lodges for want of Nouriſhment, is, that a rich Acre has maintain'd a Crop of Five Quarters ſtanding, when another poorer Acre was not able to ſupport a Crop from falling, which was but large enough to have brought Three Quarters, if it had ſtood; and this in the ſame Year, and on the ſame Situation. And 'tis very plain, that if one Acre was twice as rich as the other, it muſt be able to nouriſh Five Quarters better than the other could nouriſh Three Quarters.

Air is neceſſary to the Life and Health of all Plants, tho' in very different Degrees: Aquatics, which live under Water, are content with as little Air, as their Companions the Fiſhes.

But Wheat, being a terreſtrial Plant (tho' in Winter it will live many Days under Water, whilſt the ſlow Motion of its Sap gives it little or no Increaſe), requires a free open Air, and does not ſucceed ſo well in low ſheltery Places, as upon higher and opener Situations; where the Air has a greater Motion, and can more eaſily carry off the Recrements from the Leaves, after it has ſhaken off the Dews and Rains, which would otherwiſe ſuffocate the Plants; and therefore the Leaves are made ſo ſuſceptible of Motion from the Air, which frees them from the Dews, that would ſtop in the Recrements at the *Veſiculæ* of the Leaves, but ſhaken down will nouriſh the Plants at the Roots: The want of this Motion weakening the Wheat, 'tis (as Animals in the like ſickly Caſe are) the more unable to ſtand, and the more liable to be preſs'd down by the Weight of Rain-water, and more unable to riſe up again when down: All which Evils are remov'd by the free Motion of the Air, which ſhakes off both Dews and Rains, and thus contributes to prevent the falling (or lodging) of Wheat.

A great Quantity alſo of the Sun's Rays is neceſſary to keep Wheat ſtrong, and in Health; and in *Egypt*, and other hot Countries, it is not ſo apt to fall, as it is when ſown in Northern Climates, tho' the Produce of the South be the greateſt *(a)*.

It may be obſerv'd, that every Leaf is inſerted into a ſort of Knot, which probably delivers the Sap to be depurated at the *Veſiculæ* of the Leaves, and then receives it back again for the Nouriſhment of the Plant, doing for that Purpoſe the Office of an Heart: But the Sun with his Rays ſupplies the Part of Pulſe, to keep the Sap in Motion, and carry on its Circulation, inſtead of the Heart's *Syſtole* and *Diaſtole*. Wheat, being doubtleſs originally a Native of a hot Country, requires by its Conſtitution a conſiderable Degree of Heat to bring it to Perfection; and if much of that Degree be wanting, the Wheat will be the weaker; and when the Solar Rays cannot reach the lower Parts of the Stalks, the loweſt Leaves and Knots cannot do their Office; for which Reaſon the Chyle muſt mount higher before it be made into Sap, and there muſt be then a greater Mixture of crude Chyle next to the Ground, as by the white

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(a) This proves that the Crop doth not lodge on account of its Bigneſs.

Colour it appears *(b)*. By this means that Part, which, if it had a due Share of the Sun's Influence, would be harden'd like a Bone or Spring, for the Support of the Stalks, for lack of that, becomes more like to a Cartilage, ſoft and weak, unable to ſuſtain the Weight of the bending Ear, which, having its greateſt *Impetus* againſt this Part, which is moſt feeble to reſiſt it, it yields, and lets it fall to the Ground; and then the Grain will be blighted.

There is alſo another Cauſe of the Blight; and that is, the Wheat's coming too late into Bloſſom. The uſual time is the Beginning of *June*; and if it be later, the Days ſhorten ſo faſt after the Solſtice, that the Autumn of the Year haſtening the Autumn of the Wheat's Life, the full Time of its Pregnancy *(c)* is not accompliſh'd; and then its Fruit, which is the Grain, becomes as it were abortive, and not full-grown. This time betwixt the Generation, Bloſſoming, and the Maturity of the Grain, is, or ought to be, about Two Months.

Therefore 'tis advantageous to haſten, what we can, the time of Bloſſoming, and to protract the time of

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(*b*) But now I ſuſpect this to be a Miſtake, it being more likely, that the white Colour of the Rind, is owing to the Abſence of the Sun and free Air, than to the Chyle, as the Skin of thoſe Parts of our own Bodies that are concealed from them, is whiter than of thoſe which are expoſed to them, though no Chyle-veſſel comes near our Skin.

(*c*) *Ut enim Mulieres habent ad Partum Dies certos, ſic Arbores ac Fruges.* Varro, *Lib.* 1. *Cap.* 44.

Menſe Maio florent; ſic Frumenta, & Ordeum, & quæ ſunt ſeminis ſingularis, Octo diebus florebunt, & deinde per Dies 40. *grandeſcunt Flore depoſito uſque ad Maturitatis Eventum.* Palladius, *Pag.* 114, 115.

Quindecim Diebus eſſe in Vaginis, Quindecim florere, Quindecim exareſcere, cum ſit maturum Frumentum. Varro, *Lib.* 1. *Cap.* 32.

But the different Heat that there is in different Climates, may alter both the Time that Plants continue in Bloſſom, and the Time betwixt the Bloſſoming and the Ripening.

Ripening: And 'tis obſerv'd, that the earlieſt ſown Wheat generally eſcapes the Blight the beſt, becauſe it comes firſt into Bloſſom.

Feeding down the Wheat with Sheep prevents the Blight, by doing what the Blight wou'd do, if the Wheat fell down; *i. e.* cauſes the Ears to be light (*a*).

And we find, that thoſe who practiſe this Method of feeding their Wheat with Sheep in the Spring, to prevent the lodging of it, have moſt commonly their Straw weak, and Ears light.

Theſe, inſtead of making the Stalks ſtrong enough to ſupport heavy Ears, make the Ears light enough to be ſupported by weak Stalks. They know that heavy Ears make the greateſt Crop; and yet they ſtill hope to have it from light ones.

They cauſe the *Blight* by the very means they make uſe of to *cure* it.

This feeding of Wheat much retards the time of its bloſſoming; and that it may bloſſom early, is one chief End of ſowing it early, to prevent the Blight. But when it is fed, what the Plants ſend up next is but a Sort of ſecond or latter Crop, which have longer to ſtand than the firſt would have required, and is always weaker than the firſt Crop would have been; and the longer time it has to continue on the Ground, the more Nouriſhment is required to maintain it; and yet, as has been ſhewn, the longer it has been ſown, the more the Earth has loſt of its Nouriſhment; and

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(*a*) Heavy Ears never fall. If they did, that would not make them light. Wheat falls ſometimes whilſt 'tis in Graſs, and before it comes into Ear; ſo far are the Ears from cauſing it to fall. This was proved by my whole Crop the laſt Harveſt, and particularly by the *Meaſured Acre*, the Ears of which, tho' prodigious large and heavy, were none of them lodg'd, when thoſe of ſown Wheat on the other Side of the Hedge were fallen down flat, and lodg'd on the Ground.

conſequently, the Crop will be yet weaker, and in more Danger of the ſtarving Blight *(b)*.

The moſt effectual Remedy againſt the Blight is that which removes all its Caſes (except ſuch extraordinary ones as Lightning); as,

First, *Want of Nouriſhment.*

The Horſe-hoe will, in wide Intervals, give Wheat, throughout all the Stages of its Life, as much Nouriſhment as the diſcreet Hoer pleaſes.

Secondly, *Want of Air.*

Air, being a Fluid, moves moſt freely in a right or ſtrait Line; for there the feweſt of its Parts meet with any Reſiſtance; as a ſtrait River runs ſwifter than a crooked one, from an equal Declivity; becauſe more of the Water ſtrikes againſt the Banks at

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(b) I am ſure, that whenever Sheep break into my drill'd Wheat in the Spring, it leſſens my Crop half, juſt as far as they eat the Rows. There are ſeveral Reaſons why Sheep are more injurious to drilled Wheat than ſown: I would not therefore be underſtood to decry the Practice of feeding ſown Wheat, when the Thickneſs and Irregularity of its Plants make it neceſſary: I have only endeavoured to ſhew, that that Practice is founded upon a falſe Theory: For, if Wheat fell down by reaſon of the Luxuriance of it, a Plant of it would be more likely to fall when ſingle, and at a great Diſtance from every other Plant, than when near to other Plants, becauſe ſuch a ſingle Plant is (*cæteris paribus*) always the moſt luxuriant; and I have not ſeen ſuch a one fall (except Birds pull down the Ears), but have obſerved the contrary, though its Ears are the largeſt.

The Subject I write on is Drilling and Hoeing, and of whatſoever elſe I think relates to the Practice or Theory thereof; which obliges me to adviſe againſt Drilling too thick upon any Sort of Land; but more eſpecially upon very rich Land: For though I have no ſuch Land, yet I apprehend, that a too great Number of Plants may overſtock the Rows, and cauſe them to be liable to ſome of the Inconveniencies of ſown Wheat; and in ſuch a Caſe, perhaps, Sheep may be rather uſeful than prejudicial to the drilled Wheat; but of this I have had no Experience: And if it ſhould be too thick, it will be owing to the Fault of the Manager or Driller; but, I ſuppoſe, it might be a better Remedy to cut out the ſuperfluous Plants by the Hand-hoe, in the manner that ſuperfluous Turneps are hoed out.

the Turnings, and is there ſomewhat retarded; and the reſt moving no faſter than in the ſtrait River, the whole Stream of the crooked muſt be ſlower in its Courſe, than that of the ſtrait River.

The Air cannot paſs thro' ſown Corn in a direct Line, becauſe it muſt ſtrike againſt, and go round every Plant, they ſtanding all in the Way of its Courſe, which muſt ſtop its Current near the Earth.

And the Air amongſt ſown Corn is like Water amongſt Reeds or Oſiers in the Side of a River; it is ſo ſtopp'd in its Courſe, that it almoſt becomes an Eddy; and ſince Air is about Eight hundred times lighter than Water, we may ſuppoſe its Current thro' the Corn is more eaſily retarded, eſpecially near the Earth, where the Corn has occaſion for the greateſt Quantity of Air to paſs: For, tho' the upper Part of the Wheat be not able to ſtop a ſlow Current of Air, yet it does ſo much raiſe even a ſwift one, as to throw it off from the Ground, and hinder it from reaching the lower Parts of the Stalks, where the Air muſt therefore remain, in a manner, ſtagnant; and the thicker the Wheat is, where it ſtands promiſcuouſly, the leſs Change of Air can it have, tho' the greater the Number of the Stalks is, the more freſh Air they muſt require.

But the confuſed Manner in which the Plants of ſown Wheat ſtand, is ſuch, that they muſt all oppoſe the free Entrance of Air amongſt them, from whatever Point of the Compaſs it comes.

Now it is quite otherwiſe with Wheat drill'd regularly with wide Intervals; for therein the Current of Air may paſs freely (like Water in a ſtrait River, where there is no Reſiſtance), and communicate its Nitre to the lower as well as upper Leaves, and carry off the Recrements they emit, not ſuffering the Plants to be weaken'd, as an Animal is, when his Lungs are forc'd to take back their own Expirations, if debarr'd from a ſufficient Supply of freſh untainted Air. And this Benefit of freſh Air is plentifully, and pretty equally, diſtributed to every Row in a Field of ho'd Wheat.

Thirdly, *Want of the Sun's Rays.*

Sown Wheat-plants, by their irregular Poſition, may be ſaid to ſtand in one another's Light, for want of which they are apt to fall.

'Tis true the whole Field of Plants receive the ſame Quantity of Sun-beams amongſt them, whether they ſtand confuſedly, or in Order: But there is a vaſt Difference in the Diſtribution of them; for none or the very leaſt Share of Beams is obtain'd by thoſe Parts which need the greateſt Share, in the confuſed Plants. And when the crural Parts, that ſhould ſupport the whole Body of every Plant, are depriv'd of their due Share of what is ſo neceſſary to ſtrengthen them, the Plants (like Animals in the ſame Caſe) are unable to ſtand.

But in drill'd Wheat, where the Plants ſtand in a regular Order, the Sun-beams are more duly diſtributed to all Parts of the Plants in the Ranks; for which Way ſoever the Rows are directed, if they be ſtrait, the Rays muſt, ſome time of the Day, fall on the Intervals, and be reflected by the Ground, whence the lower Parts of the Wheat-ſtalks muſt receive the greater Share of Heat, being neareſt to the Point of Incidence, having no Weeds to ſhadow them.

As to that Cauſe of the Blight, *viz.* the Wheat's dying before the full Time of its Pregnancy be accompliſh'd; the Hoe removes all the Objections againſt planting early, and then it will bloſſom the earlier: And it has viſibly kept Wheat green a whole Week longer, than unho'd Wheat adjoining to it, planted the ſame Day.

The Antients were perfect Maſters of the Vine-Huſbandry, which ſeems to have ſo engroſs'd their rural Studies, that it did not allow them ſo much Reflection, as to apply the Uſe of thoſe Methods to the

Increaſe of Bread, which they had diſcover'd to be moſt beneficial for the Increaſe of Wine. One Method was, to hoe the Vines after they had bloſſom'd, in order to fill the Fruit, as in *Columella*, Lib. iv. cap. 28. *Convenit tum crebris Foſſionibus implere; nam fit uberior Pulverationibus.* And if what *Palladius* ſays, *Tit.* ix. be true of the Sarritions and Sarculations in the Month of *January*, and that if Beans do twice undergo that ſcratching Operation, they will produce much Fruit, and ſo large as to fill the Buſhel almoſt as full when ſhal'd as unſhal'd.

Faba, ſi bis Sarculetur, proficiet, & multum fructum & maximum afferet, ut ad Menſuram Modii complendi freſa propemodum ſicut integra reſpondeat.

This is to be done when Beans are Four Fingers high, and Corn when it has Four or Five Leaves to a Plant; even then the Harrowing-work, tho' it tore up ſome of the Plants, yet it was obſerv'd to do Good againſt the Blight.

Si ſiccas Segetes ſarculaveris, aliquid contra Rubiginem præſtitiſti, maxime ſi Ordeum ſiccum ſarrietur.

When the Antients obſerv'd this, 'tis a Wonder they did not plant their Corn ſo as to be capable of receiving this Benefit in Perfection. They might have imagin'd, that what was effectual againſt the Blight, when the Corn was in Graſs, muſt, in all Probability, be much more effectual when in Ear.

But the moſt general Blight that happens to Wheat in cold Climates, is cauſed by Inſects, which (ſome think) are brought in the Air by an Eaſt Wind accompanied with Moiſture, a little before the Grain is filling with that milky Juice, which afterwards hardens into Flour. Theſe Inſects depoſit their Eggs within the outer Skin (or Rind) of the Stalks; and when the young ones are hatched, they feed on the *Parenchyma*, and eat off many of the Veſſels which ſhould make and convey this Juice; and then the Grain will be more or leſs thin, in proportion to the

Number of Veſſels eaten, and as the Inſects happen to come earlier or later; for ſometimes they come ſo late, that the Grain is ſufficiently fill'd with the ſaid milky Juice before the Veſſels are eaten; and then, tho' the Straw appear thro' a Microſcope to have its Veſſels very much eaten and torn, and to be full of black Spots (which Spots are nothing elſe but the Excrements of thoſe young Inſects), yet the Grain is plump, and not blighted, there being an Obſervation, That the early ſown Wheat generally eſcapes this Blight. And it has been ſeen, where one Part of a Field is ſown earlier than the other Part, without any other Difference than the time of ſowing, that the Grain of the lateſt ſown has been much blighted, and the Grain of the earlier has eſcaped the Blight, tho' the Straw of both were equally eaten by the Inſects. Hence it may be inferr'd, that the Milk in the one had receiv'd all the Nouriſhment neceſſary to its due Conſiſtence, before the Veſſels were deſtroy'd; but, in the other, the Veſſels, which ſhould have continued the Supply of Nouriſhment for thickening the Milk, being ſpoil'd before they have finiſh'd that Office, it remains too thin; and then the Grain, when it hardeneth, ſhrinks up, and is blighted; yet the Grain of one and the other are equally plump until they become hard: The Difference therefore is only in the Thickneſs of the Milk, that in the blighted being more watery than the other.

The chief Argument to prove, that theſe Inſects are brought by an Eaſt Wind, is, that the Wheat on the Eaſt Sides of Hedges are much blighted, when that on the Weſt Sides is not hurt: And as to the Objection, that they are bred in the Earth, and crawl thence up the Stalks of the Wheat, becauſe ſome Land is much more ſubject to produce blighted Wheat than other Land is; perhaps this Difference may be chiefly owing to the different Situation of thoſe Lands, as they are oppoſed to the *Eaſt*, or to the *Weſt*.

Another Cauſe why ſome Wheat is more blighted than other Wheat on the ſame Land, is, the different Condition in which the Inſects find it; for the Rind of that which is very ſtrong and flouriſhing (*c*) is ſoft and tender; into this they can eaſily penetrate to lay their Eggs; but the Wheat that is poor and yellow, has an hard tough Skin (or Rind), into which the Inſects are not able to bore for the Intromiſſion of their Eggs, and therefore can do it no Miſchief. It would be in vain to adviſe to prevent the Blight, by ſtriving to make the Wheat poor; for tho' Poverty may preſerve Wheat from this Blight, as well as it does People from the Gout, yet that is a Remedy which few take willingly againſt either of theſe Diſeaſes: But this, I think, might be poſſible to remedy it, if we could, from the ſtrongeſt Wheat, take away ſo much Nouriſhment as to turn its Colour (*d*) a little yellowiſh juſt before the Inſects come (*e*), which I ſuppoſe to be in *June*, after the Ear is out, or at leaſt fully formed.

Yet this can only be done in wide Intervals; for, unleſs the fine Earth can be thruſt to ſome conſiderable Diſtance from the Roots after they are cut off, they will ſoon ſhoot out again, and reach it, becoming more vigorous thereby.

In dry Summers this Misfortune ſeldom happens, much Heat, and very little Moiſture, being moſt agreeable to the Conſtitution of Wheat; for then its Rind

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(*c*) Some Sort of Land is more ſubject to this Blight than others; in ſuch, Lammas Wheat muſt by no means be drill'd late, and too thin, leſt it ſhould not tiller till late in the Spring; and then, for want of a ſufficient Quantity of Stalks to diſpenſe with all the Nouriſhment rais'd by the Hoe, may become too vigorous and luxuriant, and be the more liable to the Injury of the Blight of Inſects.

(*d*) But this is a very difficult Matter.

(*e*) Whither thoſe Inſects go, or where they reſide, from the Time of their eating their Way out of the Straw, until they return the next Year, I cannot learn.

is more firm and hard, as it is, on the contrary, made more ſoft and ſpongy by too much Moiſture.

The moſt eaſy and ſure Remedy that I have yet found againſt the Injury of theſe Inſects, is, to plant a Sort of Wheat that is leaſt liable to be hurt by them; *viz.* The *White-cone* (or bearded) *Wheat*, which has its Stalk or Straw like a Ruſh, not hollow, but full of Pith (except near the lower Part, and there 'tis very thick and ſtrong): 'Tis probable it has Sap-veſſels that lie deeper, ſo as the young Inſects cannot totally deſtroy them, as they do in other Wheat: For when the Straw has the black Spots, which ſhew that the Inſects have been there bred, yet the Grain is plump; when the Grey-cone and Lammas Wheat mixt with it are blighted. This Difference might have been from the different times of ripening, this being ripe about a Week earlier than the Grey-cone, and later than the Lammas: But its being planted together both early and late, and at all times of the Wheat-ſeed time, and this White-cone always eſcaping with its Grain unhurt, is an Argument, that 'tis naturally fortify'd againſt the Injury of theſe Inſects, which in wet Summers are ſo pernicious to other Sorts of Wheat; and I can impute it to no other Cauſe than the different Deepneſs of the Veſſels, the Straw of other Wheat being very much thinner, and hollow from Top to Bottom; this having a ſmall Hollow at Bottom, and there the Thickneſs betwixt the outer Skin and the Cavity is more than double to that in other Sorts of Wheat; ſo that I imagine, the Inſects reach only the outermoſt Veſſels, and enough of the inner Veſſels are left untouch'd to ſupply the Grain.

This Wheat makes very good Bread, if the Miller does not grind it too ſmall, or the Baker make his Dough too hard, it requiring to be made ſofter than that of other Flour.

A Buſhel of this White-cone Wheat will make more Bread than a Buſhel of Lammas, and of the ſame Goodneſs; but it gives a little yellow Caſt to the Bread.

Another Sort of lodging Blight there is, which ſome call *Moar-Loore*, and moſtly happens on light Land: This is when the Earth, ſinking away from the Roots, leaves the Bottom of the Stalk higher than the ſubſided Ground; and then the Plant, having only theſe naked Roots to ſupport it (for which they are too weak), falls down to the Earth.

To remedy this, turn a ſhallow Furrow againſt the Rows, when they are ſtrong enough to bear it, and when the Mould is very fine and dry; then the Motion of the Stalks by the Wind will cauſe ſuch Earth to run through the Rows, and ſettle about the Roots, and cover them *(f)*.

I have never ſeen any drill'd Wheat ſo much ſpoil'd by falling, as ſown Wheat ſometimes is. The drill'd never falls ſo cloſe to the Ground, but that the Air enters into Hollows that are under it, and the Wind keeps the Ears in Motion. Notwithſtanding all the Precaution that can be uſed, in ſome unſeaſonable Years Wheat will be blighted: I have known ſuch a general Blight, when ſome of my Lammas Wheat, planted late on blighting Land, was blighted, amongſt the reſt of my Neighbours, by the Inſects; but the Grain of the ſown Wheat was vaſtly more injured than

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(f) Some Land is very ſubject to the Misfortune of expoſing the Roots, and therefore is leſs proper for Wheat; for, when the Roots are left bare to the Air, they will be ſhrivelled, and unable to ſupport the Plants: And on ſuch Lands the Wheat-plants have all fallen down, though in Number and Bigneſs not ſufficient to have produced the Fourth Part of a tolerable Crop, if they had ſtood.

I am inclined to believe, that a thorough Tillage might be a Remedy to ſuch a looſe hollow Soil; for 'tis certain to a Demonſtration, that it would render it more *denſe*, and increaſe its ſpecific Gravity: But to enrich it ſufficiently without Manure, the Tillage muſt pulverize it much more minutely, and expoſe it longer, than is required for the ſtrongeſt Land: The Fold alſo will be very helpful on ſuch hollow Land.

than that of the drill'd: The former was ſo *light*, that the greateſt Part was blown away in winnowing, and the Remainder ſo *bad*, that it was not fit to make Bread: The drill'd, made as good Bread, and had as much Flour in it, as the ſown Wheat had, that was not blighted; for the Grains of the drill'd were much larger than thoſe of the ſown; being form'd to have been twice as big as the Grains of Wheat generally are, had they not been blighted.

CHAP. XII.

Of St. Foin.

St. Foin, from the Country we brought it from, is call'd *French Graſs:* And for its long Continuance, ſome having laſted Forty Years, 'tis call'd *Everlaſting Graſs*, tho' it be not ſtrictly a *Gramen*.

'Tis call'd in *French*, *Sain Foin*, i. e. *Sanum Fœnum*, from its Quality of Wholſomeneſs, beyond the other artificial Graſſes, green and dry .'Tis alſo call'd *Sanctum Fœnum*, Holy Hay.

'Tis a Plant ſo generally known to every body, that there is no need to give any formal Deſcription of that Part of it which appears above-ground. It has many red Flowers, ſometimes leaving Ears Five or Six Inches long: I have meaſured the Stalks, and found them above Five Feet long, tho' they are commonly but about Two Feet.

The Reaſon why *St. Foin* will, in poor Ground, make a Forty times greater Increaſe than the natural Turf, is the prodigious Length (*a*) of its perpendicular

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(*a*) There is a vulgar Opinion, that *St. Foin* will not ſucceed on any Land, where there is not an under *Stratum* of Stone or Chalk, cular Tap-root: It is ſaid to deſcend Twenty or Thirty Feet. I have been inform'd by a Perſon of undoubted Credit, that he has broken off one of theſe Roots in a Pit, and meaſured the Part broken off, and found it Fourteen Feet.

This Tap-root has alſo a Multitude of very long horizontal Roots at the upper Part thereof, which fill all the upper *Stratum*, or Staple of the Ground; and of Thouſands of *St. Foin* Roots I have ſeen taken up, I never found one that was without horizontal Roots near the Surface, after one Summer's Growth; and do much wonder how Mr. *Kerkham* ſhould be ſo miſtaken, as to think they have none ſuch.

Alſo theſe Tap-roots have the horizontal ones all the Way down; but as they deſcend, they are ſtill ſhorter and ſhorter, as the uppermoſt are always the longeſt.

Any dry Ground may be made to produce this noble Plant, be it never ſo poor; but the richeſt Soil will yield the moſt of it, and the beſt.

Chalk, to ſtop the Roots from running deep; elſe, they ſay, the Plants ſpend themſelves in the Roots only, and cannot thrive in thoſe Parts of them which are above the Ground. I am almoſt aſhamed to give an Anſwer to this.

'Tis certain that every Plant is nouriſhed from its Roots (as an Animal is by its Guts); and the more and larger Roots it has, the more Nouriſhment it receives, and proſpers in proportion to it. *St. Foin* always ſucceeds where its Roots run deep; and when it does not ſucceed, it never lives to have long Roots; neither can there ever be found a Plant of it, that lives ſo long as to root deep in a Soil that is improper for it: Therefore 'tis amazing to hear ſuch Reaſoning from Men.

An under *Stratum* of very ſtrong Clay, or other Earth, which holds Water, may make a Soil improper for it; becauſe the Water kills the Root, and never ſuffers it to grow to Perfection, or to attain to its natural Bulk. The beſt *St. Foin* that ever I ſaw, had nothing in the Soil to obſtruct the Roots, and it has been found to have Roots of a prodigious Depth. If there be Springs near (or within ſeveral Feet of) the Surface of the Soil, *St. Foin* will die therein in Winter, even after it has been vigorous in the firſt Summer; and alſo after it hath produced a great Crop in the ſecond Summer.

If you venture to plant it with the Drill, according to the Method wherein I have always had the beſt Succeſs; let the Land be well prepared before you plant it. The Seed, if not well ordered, will very little of it grow; therefore 'tis convenient to try it in the manner mention'd in the Chapter of *Hoeing*; where are alſo Directions to find the proper Quantity and Depth to plant it at: I have obſerv'd, that the Heads of theſe Seeds are ſo large, and their Necks ſo weak (*b*), that if they lie much more than half an Inch (*c*) deep, they are not able to riſe through the incumbent Mould; or if they are not cover'd, they will be malted (*d*). A Buſhel to an Acre is full Twenty Seeds to each ſquare Foot, in all I try'd; but there is odds in the Largeneſs of it, which makes ſome Difference in the Number.

The worſt Seaſons to plant it are the Beginning of Winter, and in the Drought of Summer: The beſt Seaſon is early in the Spring.

'Tis the ſtronger when planted alone, and when no other Crop is ſown with it (*f*).

If

(*b*) The Kernel or Seed, being much ſwollen in the Ground, I call the Head: This, when it reaches above the Ground, opens in the Middle, and is formed into the Two firſt Leaves; the Huſk always remaining at the ſame Depth at which it is cover'd: The String that paſſes from the Huſk to the Head, is the Neck; which, when by its too great Length 'tis unable to ſupport the Head till it reaches to the Air, riſes up, and doubles above it; and when it does ſo, the Head, being turn'd with its Top downwards, never can riſe any higher, but there rots in the Ground.

(*c*) In very light Land the Seed will come up from a greater Depth; but the moſt ſecure Way is, not to ſuffer it to be cover'd deep in any Land.

(*d*) We ſay it is malted when it lies above-ground, and ſends out its Root, which is killed by the Air. And whether we plant *bad* Seed that does not grow, or *good* Seed buried or malted, the Conſequence will be much the ſame, and the Ground may be equally underſtock'd with Plants.

(*f*) The worſt Crop than can be ſown amongſt *St. Foin*, is Clover or Rye-Graſs; Barley or Oats continue but a little while to

If Barley, Oats, or other Corn ſown with St. Foin, do lodge, it will kill *(g)* the young St. Foin that is under it: But then ſo great a Crop of Corn will certainly anſwer the very little Expence of drilling the St. Foin again, either the next Year, or as ſoon as the Corn is off the Ground.

St. Foin drill'd betwixt Rows of Barley or Oats, always is ſtronger than when drill'd amongſt Corn that is ſown at random; and therefore is in leſs Danger of being kill'd by the Lodging of the Corn; neither is the Corn in Rows ſo liable to fall as the other.

The Quantity of Seed to be drill'd on an Acre will depend, in great meaſure, upon the Goodneſs of it; for in ſome bad Seed, not more than One in Ten will grow; and in good Seed, not One in Twenty will miſs; which is beſt known by ſtripping off the Huſks of a certain Number of Seeds, and planting the Kernels in Earth, in the manner directed for

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to rob it; but the other Artificial Graſſes rob it for a Year or Two, until the Artificial Paſture is near loſt; and then the St. Foin never arrives to half the Perfection as it will do when no other Graſs is ſown amongſt it.

The Injury theſe Hay-crops do to the St. Foin is beſt ſeen where ſome Parts of the ſame Field have them, and the other Parts are without them.

(g) When Barley, among which the St. Foin is planted in a dry Summer, is great, there are few Farmers that know till the next Spring, whether the St. Foin ſucceeds or not; becauſe the young Plants are not then viſible; unleſs it be to thoſe who are accuſtomed to obſerve them in all the Degrees of their Growth. I have ſeen a Field of Ten Acres of ſuch, wherein, after the Barley was carried off, nothing appeared like St. Foin; but when by the Print of the Chanels I ſearched diligently, I found the ſmall St. Foin Plants thick enough in the Rows; they had no Leaves, they being cut off by the Scythe; no Part of them that was left had any Green Colour; but from the Plants there came out many Sprigs like Hogs Briſtles, or like the Beard of Barley: This whole Piece of St. Foin ſucceeded ſo well, that the Third Year its Crop was worth Three Pounds *per* Acre, the Land being good.

finding the proper Depth to plant at, which, in this Caſe, let be half an Inch: This being done, the Quality of the Seed will be known. But until frequent Trials have furniſh'd Experience enough to the Planter to know the Difference, let him obſerve, that the following are good Signs; *viz.* The Huſk of a bright Colour, the Kernel plump, of a light-grey or blue Colour, or ſometimes of a ſhining Black; yet the Seed may be good, tho' the Huſk is of a dark Colour, if that is cauſed by its receiving Rain in the Field, and not by heating in a Heap, or in the Mow; and if you cut the Kernel off in the Middle, croſs-ways, and find the Inſide of a Greeniſh freſh Colour, it's ſurely good; but if of a yellowiſh Colour, and friable about the Navel, and thin, or pitted, theſe are Marks of bad Seed.

The Quantity, or rather Number of Seeds convenient to drill, ought to be computed by the Number of Plants *(b)* we propoſe to have for making the beſt Crop, allowing for Caſualties *(c)*.

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(*b*) Not that we need to be ſo exact as to the Number of Plants, whether they be Two, Three, or Four hundred upon a ſquare Perch. Neither is it poſſible to know beforehand the preciſe Number of Plants that may live; for ſometimes the Grub kills many, by eating off the firſt Two Leaves.

(*c*) Many even of the beſt of Seeds, both ſown and drill'd, are liable to Caſualties, but not equally; for about Twenty-eight Years ago, my Servants (being prime Seedſmen) had a Fancy in my Abſence to try an Experiment of the Difference betwixt ſowing and drilling of St. Foin; and in the Middle of a large Field of my beſt Land they ſow'd a ſquare Piece of Three Acres, at the Rate of One Buſhel to an Acre, not doubting but, by their ſkill in ſowing even, it would ſucceed as well as if drill'd; but it ſucceeded ſo much againſt their Expectation, that the Land all round it, which was drill'd at the ſame time, with the ſame Proportion of the ſame Seed, brought extraordinary good Crops of St. Foin; but the ſow'd Part was ſo very thin, that tho' it lay ſtill with the reſt for Eight Years, it never was a Crop, there not being above Three or Four upon a ſquare Perch, taking the Three Acres all together: Not that it can be ſuppoſed,

that

In drilling St. Foin not to be ho'd, and before the Ploughs of my Drill were ſo perfect in making narrow Chanels as they are now (for, when the Chanels were open, they had Six times the Breadth, wherein Part of the Seed was waſted), then my Quantity was One Buſhel to an Acre, ſometimes Six Gallons.

But a ſingle Acre (in the middle of a large Field of St. Foin) being drill'd late in *October*, the froſty Winter kill'd at leaſt Nineteen of Twenty Parts *(d)* of that Buſhel. At firſt it made ſuch a poor Appearance, that 'twas by mere Accident, or it had been plow'd up for a Fallow; but, miſſing of that, a few Plants were perceiv'd in the Summer, which by their Singleneſs grew ſo vigorous, and ſo very large, that the Second Year of Mowing it *(e)* produc'd a Crop double to the reſt of the ſame Field, which was drill'd in the Spring, with the ſame Proportion of Seed, and none of it kill'd; tho' all this Field was a much better Crop than ſome that was ſown in the common Manner, with Seven Buſhels to an Acre. I have generally obſerv'd the thin *(f)* to make the beſt Crop, after the Firſt or Second Year.

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that the ſown would always meet with ſo many Caſualties as this did; for then Eight Buſhels ſown to an Acre might have been too thin, and much thinner than all the reſt of the Field was, tho' drill'd with only One Buſhel to an Acre: And 'tis often ſeen, that when an Acre is ſown with Seven Buſhels of Seed, the St. Foin is as much too thick, as that ſown with One Buſhel was too thin.

I do not know, that of the many Hundred Acres of St. Foin, that have been drill'd for me, ever One Acre was too thin, except when planted with Wheat: The young Plants were kill'd by the Froſt.

(*d*) But I believe, there might remain alive Three or Four Plants to each ſquare Yard, ſtanding ſingle, and at pretty equal Diſtances.

(*e*) But *Note*, This Acre was dunged, and in better Order than the reſt.

(*f*) But, notwithſtanding I commend the Planting of St. Foin thin, that moſt of the Roots may be ſingle; yet I have Fields that

I have alſo often obſerv'd in Lands of St. Foin, lying diſperſed in a common Field (but where there was not Common for Sheep), and where the Ends of other Lands kept in Tillage, pointed againſt the Pieces of St. Foin, and the Horſes and Ploughs turning out upon the St. Foin *(g)* did plow and ſcratch out a Multitude of its Plants; ſo that it was thought to be ſpoil'd, and Law-ſuits were intended for Recompence of the Damage; that afterwards this ſcratch'd Part, ſuppoſed to be ſpoil'd, became twice as good as the reſt of the ſame Pieces, where the Ploughs did not come to tear up any Plants.

The Reaſon why the ſingle St. Foin Plants make the greateſt Crops, is, that the Quantity of the Crop is always in proportion to the Quantity of Nouriſhment it receives from the Earth; and thoſe Plants which run deepeſt will receive moſt; and ſuch as are ſingle will run deeper than thoſe which are not ſingle.

Alſo the ſingle do ſend out all round them horizontal Roots, proportionably ſtronger and larger, whereby they are better able to penetrate, and extract more Nouriſhment from the Staple, or upper *Stratum*, than the other can do, if there be a competent Number; which is, when ho'd, fewer than any-

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that were drill'd with but Four Gallons of Seed to an Acre; and yet the Rows being Seven Inches aſunder, the Roots are ſo thick in them, that the Ground is cover'd with the St. Foin Plants, which ſeem to be as thick (in Appearance) as moſt ſown St. Foin, whereon Seven or Eight Buſhels are ſown on an Acre. And I have other Fields that were drill'd with about Two Gallons of Seed to an Acre (which is Five Seeds to each ſquare Feet), the Rows Sixteen Inches aſunder, that produce better Crops, tho' the Ground be poorer. The drill'd St. Foin, being regular, is more ſingle, tho' as thick as the ſown; and for that Reaſon always makes a better Crop, and laſts longer, than the ſown that is of the ſame Thickneſs, but irregular.

(g) This Plowing and Scratching was a ſort of Hoeing, which helped the St. Foin by a ſmall Degree of Pulveration, as well as by making the Plants thinner.

body imagines). 'Tis common to ſee a ſingle St. Foin have a bigger Tap-root than Twenty thick ones: Their Length is in proportion to their Bigneſs: Therefore that ſingle Plant may well be ſuppoſed to have Twenty times more Depth of Earth to ſupply it, than all thoſe Twenty ſmall Roots can reach to. And tho' theſe under *Strata* are not ſo rich as the upper; yet, never having been drain'd by any Vegetable, they do afford a very conſiderable Quantity of Nouriſhment to thoſe Roots which firſt enter them.

The ſmall thick Plants are ſo far from equalling the Product of the ſingle, by their Exceſs of Number, that the more they are, the ſmaller, ſhorter, and weaker they become; leſs Nouriſhment they have, and the leſs Crop they produce; and are ſoon ſtarv'd, decay, and die, unleſs reliev'd by the Expence of frequent Manure, or that the Soil be very rich.

Single Plants exceed the other by a Multitude of Degrees, more than a Giant does a Dwarf, in Strength, as well as Stature; and therefore when natural Graſs happens to come, are ſo much the better able to ſhift amongſt it.

The ſingle Plants ſeem alſo to exceed the other in their Longevity; for 'tis obſerv'd, that all St. Foin that has continu'd good for a great Number of Years without Manure, has been ſo ſingle, that the Owners have determined to plow it up at the Beginning, for the Thinneſs of it.

How long this may laſt by Culture, I can't tell; but undoubtedly much longer than without it; and I can ſay, that I never knew a Plant of St. Foin die a natural Death; the moſt common End of it is Starving. And when an Hundred thick Plants have not the Nouriſhment which One ſingle Plant has, 'tis no Wonder that theſe (in a Croud *(b)* thus beſieg'd with Hunger) ſhould be ſtarv'd before it.

(*b*) Sown Plants, when too thick, are crouded on every Side; but thoſe that are drill'd, have always Room enough on Two Sides of them; unleſs the Rows are too near together.

Another Advantage the ſingle have, in reſpect of Moiſture: Theſe reach to a Depth where that is never wanting, even when the upper *Stratum* or Staple is parch'd up, as appears by the Experiment of the Mints, that if any Root of a Plant has Moiſture, that Root will communicate a Share to all the reſt. Hence it is, that, in the drieſt Summer, theſe ſingle Plants make a great Crop, when the other yield next to nothing. I remember I once ſaw a Farmer coming out of a Ground with a Load of St. Foin Hay, which he aſſured me was all he could find worth Cutting, out of Forty Acres, of this thick ſort, in full Perfection, Three Years after ſowing: He valued his Load at Three Pounds; but withal ſaid it came off ſo much Ground, that the Expence of Mowing, Raking, *&c.* was more than the Value; when, in the very ſame dry Summer, there was Three Tun of St. Foin to an Acre in a Field (*i*), where it was drill'd ſingle and regularly.

And I have often obſerv'd, that where the Plants are thin, the Second Crop of them ſprings again immediately after Cutting; when Plants that ſtand thick in the ſame Ground, ſpring not till Rain comes; and I have ſeen the thin grown high enough to cut the Second time, before the other began to ſpring.

The beſt way to find what Number of theſe Plants is proper to have on a Perch of Ground, is to conſider what Quantity of Hay one large Plant will produce (for, if cultivated, they will be all ſuch).

Without Culture theſe Plants never attain to a Fourth Part of the Bulk they do with it: Therefore very few have ſeen any one Plant at its full Bigneſs. One Plant, well cultivated, has in the ſame Ground

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(*i*) This was on rich deep Land in *Oxfordſhire*; and the other St. Foin, which was ſo poor, was on thin Slate Land near *Cauſham* in *Wiltſhire* in the *Bath Road.* It is now about Thirty Years ſince.

made a greater Produce, than One thouſand ſmall ones uncultivated.

But the Hay of a large ſingle cultivated Plant will weigh more than half a Pound; and 112 Plants upon a ſquare Perch, weighing but a Quarter of a Pound apiece one with another, amount to Two Tun to an Acre.

If St. Foin be planted on ſome ſorts of Land early in the Spring, and ho'd, it may bring a Crop the ſame Summer; for I once planted a few Seeds of it on ſandy Ground in my Garden, at the End of *February*, which produced large Plants above Two Feet high, that went into Bloſſom the following *June*; tho' there was a ſevere Froſt in *March*, which kill'd abundance of Wheat, yet did not hurt theſe Plants: This ſhews that St. Foin is a quick Grower, unleſs it be planted on poor cold Ground, or for want of Culture.

And tho' the poor Land, and ill Management generally allotted to it, cauſe it to yield but One mowing Crop a Year; yet it has yielded Two great ones on rich ſandy Land, even when ſown in the common ordinary manner.

Thin St. Foin cannot be expected to cover all the Ground at firſt, any more than an Orchard of Apple-trees will, when firſt planted at Thirty Feet Diſtance from each other every Way; yet this is reckon'd a proper Diſtance to make a good and laſting Orchard. But if theſe ſhould be planted at Three Feet Diſtance, as they ſtand in the Nurſery, it would not be more unreaſonable than the common Method of ſowing St. Foin is; and there would be much the ſame Conſequence in both, from covering all the Ground at firſt Planting; except that the St. Foin, being abundantly longer rooted downwards, than Apple-trees are, has the greater Diſadvantage, when by its Thickneſs 'tis prevented from growing to its full Bulk, and Length of Roots (*k*).

The Difference is only this: People are accuſtom'd to ſee Apple-trees planted at their due Diſtance; but few have ſeen St. Foin planted and cultivated at the Diſtance moſt proper to St. Foin; or ever conſider'd about it, ſo much as to make the neceſſary Trials.

I have conſtantly found, that, upon doubling any Number of narrow Rows, having equal Number of Plants in each Row, the Crops have been very much diminiſh'd; and, upon leaving out every other Row, that is, leſſening the Number of Rows to half, the Crops are increaſed; and where Two Rows are wide aſunder at one End of a Piece, and near at the other End, the Plants are gradually leſs and leſs, as the Rows approach nearer together.

We ought never to expect a full Crop of St. Foin the Firſt Year (*l*), if we intend to have good Crops afterwards, and that it ſhall continue to produce ſuch, for the ſame Reaſons that muſt be given for planting an Orchard at other Diſtances than a Nurſery.

The common Error proceeds from miſtaking the Cauſe of a great or ſmall Crop.

Where the Spaces betwixt Rows are wide (if there be not too many Plants in them) we always ſee the St. Foin grow large, and make the greateſt Crop; but when 'tis young, or after Cutting, we ſee room

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(*k*) Horizontal-rooted Plants ſuffer no greater Injury by their Paſture's being over-ſtock'd than Cattle do; becauſe their Paſture lying near the Surface of the Ground, they have it all amongſt them: But St. Foin, and other long Tap-rooted Plants ſuffer yet more, becauſe great Part of their over-ſtock'd Paſture is loſt by them all, when they hinder one another from reaching down to it, by ſhortening one another's Roots, which they do when they all become Dwarfs by reaſon of their Over-thickneſs.

(*l*) But when it has been planted on rich ſandy Land, and proper, it has produced very great Crops the Firſt Year; but then the Summer wherein it grew amongſt the Barley, muſt not b reckoned as the Firſt Year.

(as we fanſy) for more of ſuch Plants, to make a yet larger Crop; not conſidering that 'tis the Wideneſs of thoſe Spaces, and leſs Number of Plants, that cauſe the Crop to be ſo large, there being more Paſture for thoſe Plants.

Where theſe Spaces are narrower, and the Rows of equal Thickneſs, we ſee the Plants leſs when grown, and that they make a leſs Crop; and yet there ſeems to be room for more Rows, which we fanſy might make the Crop larger, not conſidering that 'tis the Narrowneſs of thoſe Spaces that cauſes the Plants and Crop to be leſs, for want of ſufficient Paſture.

Thus, fondly increaſing the Number of our Rows and Plants, we bring our Crop (unleſs the Soil be rich) to nothing, by too much over-ſtocking their Paſture; and, if that Paſture be over-ſtock'd, the Crop will be diminiſh'd more than in proportion to that Over-charge; for perhaps 'tis not impoſſible to prove (if we would be curious), that Plants, by wanting a Fourth Part of their due *Quantum* of Nouriſhment, will be diminiſh'd to half *(m)* of the Bulk they would have attained to, had they been ſupply'd with the other Fourth Part.

I have obſerv'd ho'd St. Foin to grow more, and increaſe its Bulk more, in Two Weeks, than unho'd St. Foin in the ſame Ground (and without any other Difference) hath done in Six Weeks; and the quicker it grows by being better fed, the ſweeter and richer Food it will make for Cattle, whether it be ſpent green or dry *(n)*.

(*m*) When Plants have not their due Nouriſhment, they ſuffer the more by Cold and Drought; ſo that want of Nouriſhment diminiſhing their Growth One-fourth, Cold, or Drought, or both, may diminiſh it another Fourth.

(*n*) Cattle are the beſt Judges of the Goodneſs of Graſs, and they always chooſe to feed on St. Foin that is moſt vigorous, and refuſe that which is poor and yellow. And the richeſt ſweeteſt Graſs will always make the beſt Hay; for the drying of it does not change the Quality of the Graſs.

At whatever Diſtance the Rows be ſet, if they have too many Plants in them, the Crop will be very much injured; and the greater the Exceſs is beyond the juſt Number, the more void Space there will be amongſt them; becauſe the ſmaller the Plants are, the leſs Ground they cover.

I have had the Experience of drilling at all Diſtances, from Thirty-three Inches to Seven Inches, betwixt the Rows; and recommend the following Diſtance, for the different Methods of Drilling; whether the *St. Foin* be deſign'd for hoeing, or not. As,

Firſt, For *Horſe-hoeing*, I think it is beſt to drill double Rows with Eight-inch Partitions, and Thirty-inch Intervals; which need only be ho'd alternately, leaving every other Interval for making the Hay thereon.

Indeed I have never yet had a whole Field of ho'd *St. Foin*; but have enough to ſhew, that Horſe-hoeing makes it ſtrong upon very poor Land, and cauſes it to produce Two Crops a Year upon indifferent Land.

It is not neceſſary to hoe this every Year; but we may intermit the Hoeing for Three or Four Years together, or more, if the Land be good.

Whilſt the Plants are ſmall the Firſt Year, Care muſt be taken not to cover them with the Plough: Afterwards there will be no great Danger, eſpecially in Winter, the Earth not being ſuffered to lie on them too long.

Secondly, For *Hand-hoeing*, drill the Rows Sixteen Inches aſunder, and ſingle out the Plants, ſo as to make them Eight Inches apart at leaſt in the Rows, contriving rather to leave the Maſter-plants, than to be exact in the Diſtance: This muſt be done whilſt they are very young, or in Summer; elſe they will come again that are cut off by the Hoe.

Laſtly, When *St. Foin* is drill'd without any Intention of hoeing, the beſt Way (I think) is to plant ſingle Rows, at Eight Inches Diſtance, with no greater Quantity of Seed, than when the Rows are at Sixteen Inches Diſtance; becauſe, by this Method, the ſame Number of Plants in the Rows, that are but Eight Inches apart, will be much more ſingle, than thoſe in the Rows at Sixteen Inches apart are, without being ſet out by the Hoe.

Which of theſe Methods ſoever is practis'd, the Land ſhould be made as clean from all Graſs, and as well pulveriz'd, as poſſible, before Drilling.

The Tines of the Drill-harrow muſt exactly follow the Shares, which leaving the Chanels open, the Tines cover the Seed, ſome at Bottom, and ſome on each Side; ſo that it is cover'd very ſhallow, tho' it lies deep within the Ground, where there is more Moiſture, than nearer to the upper level Surface: This cauſes the Seed to come up in dry Weather; and yet it is not in Danger of being buried by a too great Weight of Mould incumbent on it.

But take heed that no other Harrow come on it after 'tis drill'd; for that might bury it. I never care to roll it at all, unleſs on account of the Barley; and then only in very dry Weather, with a light Roller, lengthways of the Rows, immediately after 'tis drill'd; or elſe ſtay Three Weeks afterwards before it be roll'd, for fear of breaking off the Heads of the young *St. Foin*.

Be ſure to ſuffer no Cattle to come on the young *St. Foin* the firſt Winter (*a*), after the Corn is cut that

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(*a*) The Firſt Winter is the Time to lay on Manure, after the Crop of Corn is off; ſuch as *Peat-Aſhes*, or the like; becauſe, there being no natural Graſs to partake of it, and the Plants being leſs, leſs will ſupply them; and becauſe, when made ſtrong in their Youth, they will come to greater Perfection: But I never uſed any Manure on my *St. Foin*, becauſe mine generally had no Occaſion for Manure before it was old; and *Soot* is ſeldom to be had of ſufficient Quantity in the Country; and little *Coal* is burnt hereabouts, except by the *Smiths*, whoſe *Aſhes* are not good. The Price and Carriage of *Peat-Aſh* will be Ten Shillings for an Acre, which would yet be well beſtowed in a Place where Hay is vendible; but, by reaſon of the great Quantity of watered Meadows, and Plenty of St. Foin, Clover, and Hay, raiſed of late Years by Farmers for their own Uſe, that grows amongſt it; their very Feet would injure it by treading the Ground hard, as well as their Mouths by cropping it: Nor let any Sheep come at it, even in the following Summer and Winter.

One Acre of well-drill'd *St. Foin*, conſidering the different Goodneſs of the Crops, and the Duration of it, is generally worth Two Acres of ſown *St. Foin* on the ſame Land, tho' the Expence of drilling be Twenty times leſs than the Expence of ſowing it.

One of the Cauſes why *St. Foin*, that is properly drill'd, laſteth longer (*b*) without Manure than the ſown, is, That the former neither over nor under-ſtocks the Paſture; and the latter commonly, if not always, doth one or the other, if not both; *viz.* Plants too thick in ſome Places, and too thin in others; either 'tis not ſingle, but in Bunches; or if it be ſingle, 'tis too thin; it being next to impoſſible to have the Plants come true and regular, or nearly ſo, by ſowing at *random*. Plants too thick ſoon exhauſt the Paſture they reach, which never is more than a ſmall Part of that below the Staple: When the Plants are too thin, the *St. Foin* cannot be ſaid to laſt at all, becauſe it never is a Crop.

They who *ſow* Eight or Ten Buſhels of good Seed on an Acre, in a good Seaſon, among their Corn, with Intent that by its Thickneſs it ſhould kill other Graſs, reduce their *St. Foin* almoſt to that poor Condition I have ſeen it in, where it grows naturally ſa-

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Uſe, here are now few or no Buyers of Hay, eſpecially theſe open Winters; ſo that laying out Money in that Manner, would be in Effect to buy what I cannot ſell. I think it better to let a little more Land lie ſtill in St. Foin, than to be at the Expence of Manure; but yet ſhall not neglect to uſe it, when I ſhall find it likely to be profitable to me.

(*b*) I have now a great many ſingle *St. Foin* Plants in my Fields, that are near Thirty Years of Age, and yet ſeem as young and vigorous as ever; and yet it is common for thick *St. Foin* to wear out in Nine or Ten Years, and in poor Land much ſooner, if not often manured by *Soot*, *Peat-Aſh*, or *Coal-Aſh*.

vage, without Sowing or Tillage, upon the *Calabrian* Hills near *Croto:* It makes there ſuch a deſpicable Appearance, that one would wonder how any body ſhould have taken it in their Head to propagate ſo unpromiſing a Plant; and yet there has ſcarce been an Exotic brought to *England* in this or the laſt Age, capable of making a greater or more general Improvement, were it duly cultivated.

Some think the *Cytiſus* would exceed it; but I am afraid the Labour of ſhearing thoſe Shrubs by the Hands of *Engliſh* Servants, would coſt too much of its Profit.

Luſerne, requiring more Culture, and being much more difficult to be fitted with a proper Soil, never can be ſo general as *St. Foin.*

But now let us conſider the beſt Methods of ordering *St. Foin* for Hay and Seed. The Profit of *St. Foin* Fields, ariſing from either of theſe Ways, is a great Advantage to their Owner, above that of natural Meadows; for, if Meadow-hay cannot have good Weather to be cut in its Seaſon, it can ſerve for little other Uſe than as Dung; and yet the Expence of mowing it, and carrying it off, muſt not be omitted. But if there be not Weather to cut *St. Foin* before bloſſoming, we may expect it till in Flower, or may ſtay till the Bloſſoms are off; and if it ſtill rain on, may ſtand for Seed, and turn to as good Account as any of the former: So that it has Four Chances to One of the Meadow.

The elevated, but not mountainous, Situation of the dry Land whereon *St. Foin* is moſtly planted, renders it ſo commodious for making of Hay, that it eſcapes there the Injury of Weather, when Hay in low Meadows is utterly ſpoil'd.

On the high Ground the Wind will dry more in an Hour, than on the Meadows in a whole Day. The Sun too has a more benign Influence above, and ſends off the Dew about Two Hours earlier in the

Morning, and holds it up as much longer in the Evening. By theſe Advantages the *St. Foin* has the more Time to dry, and is made with half the Expence of Meadow-hay.

But before the Manner of making it be deſcrib'd, the proper Time of cutting it ought to be determin'd; and upon that depend the Degrees of its Excellence (beſides upon the Weather, which is not in our Power); for tho' all Sorts of this Hay, if well made, be good, yet there is a vaſt Difference and Variety in them.

The ſeveral Sorts may be principally diſtinguiſh'd by the following Terms; *viz.* Firſt, The *Virgin.* Secondly, The *Bloſſom'd.* Thirdly, The *Full-grown.* And, Fourthly, The *Threſh'd Hay.*

The Firſt of theſe is beſt of all, beyond Compariſon; and (except *Luſerne)* has not in the World its equal. This muſt be cut before the Bloſſoms appear: For when it ſtands till full-blown, the moſt ſpirituous, volatile, and nouriſhing Parts of its Juices are ſpent on the next Generation; and this being done all at once, the Sap is much depauperated, and the *St. Foin* can never recover that Richneſs it had in its Virgin State. And tho', when in Bloſſom, it be *literally* in the *Flower* of its Age, 'tis really in the Declenſion of it. If it be ſaid, that what is not in the Stalk is gone into the Flower, 'tis a Miſtake; becauſe much the greateſt Part of its Quinteſſence perſpires thence into the Atmoſphere.

And moreover, That all Vegetables are, in ſome degree, weaken'd by the Action of continuing their Kind, may be inferr'd from thoſe Plants which will live ſeveral Years, if not ſuffer'd to bloſſom; but, whenever they bloſſom, it cauſes their Death, tho' in the firſt Year of their Life. For in Plants (as Dr. *Willis* obſerves in Animals) Nature is more ſolicitous to continue the Species, than for the Benefit of the Individual.

Part of a drill'd *St. Foin* Ground was cut the Beginning of *May*, before bloſſoming (*c*); and from the Time of cutting, until it was ſet up in Ricks, being about Ten Days, the Sun never ſhone upon it (*d*); but the Weather was miſty: At laſt it was forc'd to be carried together for fear of Rain, ſo green, that out of the largeſt Stalks one might wring milky Juice; yet by making the Hay up in ſeveral little Ricks, and drawing up a great Chaff Baſket in the Middle of each, its Firing was prevented; but it look'd of a dark Colour by heating; and was the very beſt (*e*) Hay that ever I had.

The other Part of the Ground was afterwards cut in the Prime of its Flower, and made into Hay by the Heat of the Sun, without Rain or Miſt: This came out of the Ricks at Winter with a much finer Colour, and as fine a Smell as the Virgin Hay; but did not come near it in fatting Sheep, or keeping

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(*c*) By cutting before bloſſoming, is not meant before any one Bloſſom appears; for here-and-there a Bud will begin to open with a red Colour long before the reſt: Therefore, when we perceive only a very few Bloſſoms beginning to open (perhaps but One of a Thouſand), we regard them as none.

(*d*) This alſo was an Advantage to this Hay; for Apothecaries find, that Herbs dried in the Shade retain much more of their Virtue than thoſe dried in the Sun; but Farmers not having any ſuch Conveniency of drying their Hay in the Shade with Safety, muſt always chooſe to dry it by the Sun; becauſe in cloudy Weather there is Danger of Rain; and therefore ſuch excellent Hay muſt be had by Chance; for to be well made in the Shade, it muſt be in Danger of being ſpoiled or damaged by Rain.

(*e*) This Hay, ſo cut before bloſſoming, has kept a Team of working Stone-horſes, round the Year, fat without Corn; and when tried with Beans and Oats mixed with Chaff, they refuſed it for this Hay. The ſame fatted ſome Sheep in the Winter, in a Pen, with only it and Water; they thrived faſter than other Sheep at the ſame time fed with Peaſe and Oats. The Hay was weighed to them, and the clear Profit amounted to Four Pounds *per* Tun. They made no Waſte: Tho' the Stalks were of an extraordinary Bigneſs, they would break off ſhort, being very brittle. This grew on rich Ground in *Oxfordſhire*.

Horſes fat at hard Work, without any Corn, as the Virgin Hay did.

This ſuperfine Hay cannot well be had of poor uncultivated (*f*) *St. Foin*; becauſe that may not be much above an Handful high, when 'tis in Condition to be ſo cut; and would then make a very light Crop, and would be a great while ere it ſprang up again: But the rich will have Two or Three Tun to an Acre, and ſpring again immediately for a Second Crop; ſo that little or no Quantity would be loſt by ſo great an Improvement of it's Quality. For ho'd *St. Foin* upon a poor chalky Hill, cut at the ſame time with that uncultivated on a rich Valley, does in dry Weather grow again without Delay, when the Valley attends a Month or more for a Rain, to excite its vegetative Motion.

This Hay the Owner (if he be wiſe) will not ſell at any common Price; but endeavour to have ſome of it every Year, if poſſible, for his own Uſe.

The Second Sort of *St. Foin* Hay is that cut in the Flower; and, tho' much inferior to the *Virgin* Hay, it far exceeds any other Kind, as yet commonly propagated in *England*; and if it be a full Crop, by good Culture, may amount to above Three Tun on an Acre. This is that *St. Foin* which is moſt commonly made; and the larger it is, the more nouriſhing for Horſes. I have known Farmers, after full Experience, go Three Miles to fetch the largeſt ſtalky *St. Foin*, when they could have bought the ſmall fine leafy Sort of it at home, for the ſame Price by the Tun.

The next and laſt Sort of *St. Foin* that is cut only for Hay, is, the *full-grown*, the Bloſſoms being gone, or going off: This alſo is good Hay, tho' it fall ſhort, by many Degrees, of the other Two Sorts: It makes a greater Crop than either of them, becauſe it grows to its full Bulk, and ſhrinks little in drying.

(*f*) I reckon Manure of *Peat-Aſhes*, *Soot*, or the like, to be a Culture.

This gives the Owner a Third Chance of having Weather to make good Hay, and ſpins out the Hay-Seaſon till about *Midſummer*; and then in about a Fortnight, or Three Weeks, after the Hay is finiſh'd, the Seed is ripe. But, firſt, of the manner of making *St. Foin* Hay.

In a Day or Two after *St. Foin* is mow'd, it will, in good Weather, be dry on the upper Side: Then turn the Swarths, not ſingly, but Two and Two together; for by thus turning them in Pairs, there is a double Space of Ground betwixt Pair and Pair, which needs but once raking; whereas, if the Swarths were turn'd ſingly, that is, all the ſame Way, ſuppoſe to the *Eaſt* or *Weſt*, then all the Ground will require to be twice raked; at leaſt, more of it, than the other Way.

As ſoon as both Sides of the Swarths are dry from Rain and Dew, make them up into little Cocks the ſame Day they are turn'd, if conveniently you can; for when 'tis in Cock, a leſs Part of it will be expoſed to the Injuries of the Night, than when in Swarth.

Dew, being of a nitrous penetrating Nature, enters the Pores of thoſe Plants it reaches, and during the Night poſſeſſes the Room from whence ſome Part of the Juices is dry'd out: Thus it intimately mixes with the remaining Sap; and, when the Dew is again exhal'd, it carries up moſt of the vegetable Spirits along with it, which might have been there fix'd, had they not been taken away in that ſubtile Vehicle.

If *St. Foin* be ſpread very thin upon the Ground, and ſo remain for a Week in hot Weather, the Sun and Dew will exhauſt all its Juices, and leave it no more Virtue than is in Straw.

Therefore 'tis beſt to keep as much of our Hay as we can from being expoſed to the Dews, whilſt 'tis in making; and we have a better Opportunity of doing it in this, than in natural Hay; becauſe the bigger the Cocks are, the leſs Superficies (in proportion to the Quantity they contain) will be expoſed to the Dew; and *St. Foin* may be ſafely made in much larger Cocks than natural Hay of equal Dryneſs can, which, ſinking down cloſer, excludes the Air ſo neceſſary for keeping it ſweet, that if the Weather prevents its being frequently mov'd and open'd, it will ferment, look yellow, and be ſpoil'd. Againſt this Miſfortune there is no Remedy, but to keep it in the leſſer Cocks, until thoroughly dry. *St. Foin* Cocks (twice as big as Cocks of natural Hay), by the leſs Flexibility of the Stalk admitting the Air, will remain longer without fermenting.

This being able to endure more Days unmov'd, is alſo an Advantage upon another Account, beſides the Weather; for tho', in other Countries, People are not prohibited uſing the neceſſary Labour on *all Days* for preſerving their Hay, even where the certainer Weather makes it leſs neceſſary than here, yet 'tis otherwiſe in *England*; where many a Thouſand Load of natural Hay is ſpoil'd by that Prohibition for want of being open'd; and often, by the Loſs of one Day's Work, the Farmer loſes his Charges, and Year's Rent; which ſhews, that to make Hay while the Sun ſhines, is an exotic Proverb againſt *Engliſh* Laws; whereunto *St. Foin* being, in regard of Sundays and Holidays, more conformable, ought to be the Hay as proper to *England* as thoſe Laws are.

But to return to our Hay-makers: When the firſt Cocks have ſtood one Night, if nothing hinder, let them double, treble, or quadruple the Cocks, according as all Circumſtances require, in this manner; *viz.* Spread Two, Three, or more, together, in a freſh Place; and after an Hour or Two turn them, and make that Number up into one Cock; but when the Weather is doubtful, let not the Cocks be thrown or ſpread, but inlarge them, by ſhaking ſeveral of them into one; and thus hollowing them to let in the Air, continue increaſing their Bulk, and diminiſhing their

Number daily, until they be ſufficiently dry to be carried to the Rick.

This I have found the moſt ſecure Way: Tho' it be ſomething longer in making, there is much leſs Danger than when a great Quantity of Hay is ſpread at once; for then a ſudden Shower will do more Harm to one Acre of that, than to Twenty Acres in Cock.

And the very beſt Hay I ever knew in *England*, was of *St. Foin*, made without ever ſpreading, or the Sun's ſhining on it. This Way, tho' it be longer ere finiſh'd, is done with leſs Labour than the other.

Not only a little Rain, but even a Miſt, will turn *Clover Hay* black; but *St. Foin* will not with any Weather turn black, until it be almoſt rotten, its Leaves being thinner than thoſe of *Clover*.

If *St. Foin* be laid up pretty green, it will take no Damage, provided it be ſet in ſmall round Ricks, with a large Baſket drawn up in the Middle of each, to leave a Vent-hole there, thro' which the ſuperfluous Moiſture of the Hay tranſpires.

As ſoon as its Heating is over, theſe Ricks ought to be thatch'd; and all *St. Foin* Ricks, that are made when the Hay is full-dry'd in the Cocks, ought to be thatch'd immediately after the making them.

That which is laid up moſt dry'd, will come out of the Rick of a green Colour; that which has much heated in the Rick, will have a brown Colour.

The Seed is a Fourth Chance the Owner has to make Profit of his *St. Foin:* But this, if the *Hoeing-Huſbandry* were general, would not be vendible in great Quantities for planting; becauſe an ordinary Crop of an Acre will produce Seed enough to drill an Hundred Acres, which would not want replanting in a long time.

The other Uſe then of this Seed is for Provender; and it has been affirm'd by ſome, who have made Trials of it, that Three Buſhels of good *St. Foin*

Seed given to Horſes, will nouriſh them as much as Four Buſhels of Oats. When well order'd, it is ſo *ſweet*, that moſt Sorts of Cattle are greedy of it. I never knew ſo much of it given to Hogs, as to make them become fat Bacon; but I have known Hogs made very good Pork with it, for an Experiment; and being valued at the Beginning of their feeding, and the Pork by the Score when the Hogs were kill'd, which, computed with the Quantity of Seed they eat, did not amount to near the Value of the ſame Seed ſold for ſowing; that being Three Shillings *per* Buſhel, and the Profit made by giving it to the Hogs was but Two Shillings a Buſhel.

The Goodneſs of the Seed, and of the Hay out of which it is threſh'd, depends very much upon the manner of ordering them.

This threſh'd Hay, when not damaged by wet Weather, has been found more nouriſhing to Horſes than coarſe Water-meadow Hay; and, when 'tis cut ſmall by an Engine, is good Food for Cattle, and much better than Chaff of Corn.

It requires ſome Experience in it, to know the moſt proper Degree of Ripeneſs, at which the ſeeded *St. Foin* ought to be cut; for the Seed is never all ripe together; ſome Ears bloſſom before others; every Ear begins bloſſoming at the lower Part of it, and ſo continues gradually to do upward for many Days; and before the Flower is gone off the Top, the Bottom of the Ear has almoſt fill'd the Seeds that grow there; ſo that if we ſhould defer cutting until the top Seeds are quite ripe, the lower, which are the beſt, would ſhed, and be loſt.

The beſt time to cut is, when the greateſt Part of the Seed is well fill'd; the firſt-blown ripe, and the laſt blown beginning to be full.

The natural Colour of the Kernel, which is the real Seed, is grey or bluiſh when ripe; and the Huſk, which contains the Seed is, when ripe, of a browniſh

Colour. Both Huſk and Seed continue perfectly green for ſome time after full-grown; and if you open the Huſk, the Seed will appear exactly like a green Pea when gather'd to boil, and will, like that, eaſily be ſplit into Two Parts. Yet St. Foin Seed in this green Plight will ripen after Cutting, have as fine a Colour, and be as good in all reſpects, as that which was ripe before Cutting: Some, for want of obſerving this, have ſuffer'd their Seed to ſtand ſo long, till it was all ripe, and loſt in Cutting.

St. Foin Seed ſhould not be cut in the Heat of the Day, whilſt the Sun ſhines out; for then much, even of the unripe Seed, will ſhed in Mowing: Therefore, in very hot Weather, the Mowers ſhould begin to work very early in the Morning, or rather in the Night; and when they perceive the Seed to ſhatter, leave off, and reſt till towards the Evening.

After Cutting we muſt obſerve the ſame Rule as in mowing it; *viz.* not to make this Hay whilſt the Sun ſhines.

Sometimes it may, if the Seed be pretty ripe, be cock'd immediately after the Scythe; or if the Swarths muſt be turn'd, let it be done whilſt they are moiſt; not Two together, as in the other Hay aforemention'd. If the Swarths be turn'd with the Rake's Handle, 'tis beſt to raiſe up the Ear-ſides firſt, and let the Stub-ſide reſt on the Ground in turning; but if it be done by the Rake's Teeth, then let them take hold on the Stub-ſide, the Ears bearing on the Earth in turning over. But 'tis commonly Rain that occaſions the Swarths to want Turning *(a)*.

If it be cock'd at all *(b)*, the ſooner 'tis made into Cocks, the better; becauſe, if the Swarths be dry,

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(*a*) If the Swarths be not very great, we never turn them at all; becauſe the Sun or Wind will quickly dry them.

(b) Sometimes when we deſign to threſh in the Field, we make no Cocks at all, and but only juſt ſeparate the Swarths in the

dry, much of the Seed will be loſt in ſeparating them, the Ears being entangled together. When moiſt, the Seed ſticks faſts to the Ear; but, when dry, will drop out with the leaſt Touch or Shaking.

There are Two ways of threſhing it, the one in the Field, the other in the Barn: The firſt cannot be done but in very fine Weather, and whilſt the Sun ſhines in the Heat of the Day: The beſt Manner of this is, to have a large Sheet pegg'd down to the Ground, for Two Men with their Flails to threſh on: Two Perſons carry a ſmall Sheet by its Corners, and lay it down cloſe to a large Cock, and, with Two Sticks thruſt under the Bottom of it, gently turn it over, or lift it up upon the Sheet, and carry and throw it on the great Sheet to the Threſhers; but when the Cocks are ſmall, they carry ſeveral at once, thrown upon the little Sheet carefully with Forks; thoſe which are near, they carry to the Threſhers with the Forks only. As faſt as it is threſh'd, one Perſon ſtands to take away the Hay, and lay it into an Heap: And ſometimes a Boy ſtands upon it, to make it into a ſmall Rick of about a Load. As often as the great Sheet is full, they riddle it thro' a large Sieve to ſeparate the Seed and Chaff from the broken Stalks, and put it into Sacks to be carried into the Barn to be winnow'd.

Two Threſhers will employ Two of theſe little Sheets, and Four Perſons in bringing to them; and when the Cocks are threſh'd, which ſtand at a conſiderable Diſtance all round them, they remove the Threſhing-ſheet to another Place. There belong to a Set for one Threſhing-ſheet Seven or Eight Perſons; but the Number of Sheets ſhould be according to the

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the Dew of the Morning, dividing them into Parts of about Two Feet in each Part. By this means the St. Foin is ſooner dry'd, than when it lies thicker, as it muſt do, if made into Cocks.

Quantity to be thus threſh'd: The ſooner theſe threſh'd Cocks are remov'd, and made into bigger Ricks, the better; and unleſs they be thatch'd, the Rain will run a great way into them, and ſpoil the Hay; but they may be thatch'd with the Hay itſelf, if there be not Straw convenient for it.

But the chiefeſt Care yet remains; and that is, to cure the Seed: If that be neglected, it will be of little or no Value *(a)*; and the better it has eſcap'd the Wet in the Field, the ſooner its own Spirits will ſpoil it in the Barn or Granary. I have known it lie a Fortnight in Swarth, till the wet Weather has turn'd the Huſks quite black: This was threſh'd in the Field, and immediately put into large Veſſels, holding about Twenty Buſhels each. It had by being often wet, and often dry, been ſo exhauſted of its fiery Spirits, that it remain'd cool in the Veſſels, without ever fermenting in the leaſt, till the next Spring; and then it grew as well as ever any did that was planted.

But of Seed threſh'd in the Field, without ever being wetted, if it be immediately winnow'd, and a ſingle Buſhel laid in an Heap, or put into a Sack,

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(a) But there is yet another Care to be taken of St. Foin Seed, beſides the curing it; and that is, to keep it from Rats and Mice after 'tis cured; or elſe, if their Number be large, they will in a Winter eat up all the Seed of a conſiderable Quantity, leaving only empty Huſks, which to the Eye appear the ſame as when the Seeds are in them. A Man cannot without Difficulty take a Seed out of its Huſk; but the Vermin are ſo dextrous at it, that they will eat the Seed almoſt as faſt out of the Huſks, as if they were pulled out for them. I ſaw a Rat killed as he was running from an Heap of it, that had Seven peeled Seeds in his Mouth not ſwallowed; which is a Sign, that he was not long in taking them out. They take them out ſo cleverly, that the Hole in the Huſk ſhuts itſelf up when the Seed is out of it. But, if you feel the Huſk between your Finger and Thumb, you will find it empty. Alſo a Sackful of them is very light; yet there have been ſome ſo ignorant and incurious as to ſow ſuch empty Huſks for ſeveral Years ſucceſſively; and none coming up, they concluded their Land to be improper for St. Foin.

it will in few Days ferment to ſuch a degree, that the greateſt Part of it will loſe its vegetative Quality: The larger the Heap, the worſe: During the Fermentation it will be very hot, and ſmell ſour.

Many, to prevent this, ſpread it upon a Malt-Floor, turning it often; or, when the Quantity is ſmall, upon a Barn-floor; but ſtill I find, that this way a great deal of it is ſpoil'd; for it will heat, tho' it be ſpread but an Handful thick, and they never ſpread it thinner: Beſides, they may miſs ſome Hours of the right times of turning it; for it muſt be done very often; it ſhould be ſtirr'd in the Night as well as the Day, until the Heating be over; and yet, do what they can, it never will keep its Colour ſo bright as that which is well houſed, well dry'd, and threſh'd in the Winter: For in the Barn the Stalks keep it hollow; there are few Ears or Seeds that touch one another; and the Spirits have room to fly off by degrees, the Air entering to receive them.

The only way I have found to imitate and equal this, is to winnow it from the Sheet; then lay a Layer of Wheat-ſtraw (or if that be wanting, of very dry-threſh'd Hay); then ſpread thereon a thin Layer of Seed, and thus *Stratum ſuper ſtratum*, Six or Seven Feet high, and as much in Breadth; then begin another Stack; let there be Straw enough, and do not tread on the Stacks; by this means the Seed mixing with the Straw, will be kept cool, and come out in the Spring with as green a Colour as when it was put in, and not one Seed of a Thouſand will fail to grow when planted. A little Barn-room will contain a great Quantity in this manner.

I have had above One hundred Quarters of clean Seed thus manag'd in one Bay of a ſmall Barn. We do not ſtay to winnow it clean before we lay it up in the Straw; but only paſs it through a large Sieve, and with the Van blow out the Chaff, and winnow it clean in the Spring.

This Field-threſhing requires extraordinary fine ſun ſhiny Weather, which ſome Summers do not afford at the Seaſon, for threſhing a great Quantity of it; for 'tis but a ſmall Part of the Day in which the Seed can be threſh'd clean out. They who have a ſmall Quantity of it, do carry it into a Barn early in the Morning, or even in the Night, whilſt the Dew is on it; for then the Seed ſticks faſt to the Ear: As it dries, they threſh it out; and if they cure it well, have thus ſometimes good Seed, but generally the Hay is ſpoil'd.

There is one Method of ſaving all the Seed good, and the Hay too, by carrying it unthreſh'd to the Barn or Rick, in a particular manner, tho' it be a great Quantity, more than can preſently be threſh'd; but muſt be laid up in Mows or Ricks, as Corn is. Then if it be carry'd in, in the Dews or Damp, the Hay is ſure to be ſpoil'd, if not both Hay and Seed: When 'tis taken up dry, the Seed comes out with a Touch, and the greateſt Part is loſt in pitching up the Cocks, binding, and jolting in carrying home.

To avoid this Dilemma, a Perſon who happen'd to have a great Crop of Seed on One hundred and Fifty Acres together (and being by Weather delay'd till Wheat-harveſt came on, ſo that moſt Labourers went to Reaping) was forc'd to a Contrivance of getting it in as follows; *viz.* Three Waggons had each a Board with an Hole in, fix'd croſs the Middle of each Waggon, by Iron Pins, to the Top of the Rades or Sides: There was a Crane which a Man could lift, and ſet into the Hole in the Board, and, having an Iron Gudgeon at the Bottom, which went into a Socket in the Bottom of the Waggon, would turn quite round: The Poſt of the Crane was Ten Feet Four Inches long, its Arm Four Feet Eight Inches long, brac'd; having a treble Pulley at the End of it, and another to anſwer it with an Hook.

About Forty Sheets were provided, capable of holding each One hundred and Fifty, or Two hundred Pounds Weight of it; theſe had Knots or Buttons at the Corners and Middles, made by ſewing up a little Hay in theſe Knots, as big as Apples, into Part of the Sheet; for if any Buckle, or other thing, be ſew'd to a Sheet plain, it will tear the Sheet. Half theſe Buttons have Strings ty'd to them; theſe Sheets are ſpread among the Cocks, fill'd by Two, and ty'd up by Two other Perſons: There is alſo a light Fir Ladder, wide at Bottom, the Top of it faſten'd by a Piece of Cord to the Brace of the Crane; they hitch the Hook of the lower Pulley to a fill'd Sheet, and by a little Horſe at the End of the Pulley-rope, draw it up ſliding on the Ladder; 'tis up in a Moment: Then the Man who is below, hitches the Crook of the Pulley to the lower Round of the Ladder, and the Loader above pulls up the Ladder from the Ground, till the Waggon comes to another Sheet. The Waggons are lengthen'd by Cart-Ladders before and behind, for the more eaſy placing of the Sheets. When about Twelve or Fifteen of them are loaded, they have a Rope fix'd to the Fore-part of each Waggon, which they bring over the Top of all the loaded Sheets, and wreſt it at the Tail, to hold on the Sheets faſt from falling off with Jolting. Then the Loader pulls out the Crane, and puts it into the next Waggon in the ſame Manner. One Waggon is loading whilſt another is emptying in the Barn, by treble Pulleys likewiſe; becauſe 'tis inconvenient to take it out of the Sheets by Prongs; but the Pulleys will eaſily draw off Two or Three Sheets together. One Waggon is always going to the Field, or coming home. This Contrivance makes more Expedition than one would imagine: Three Loads have been loaded, and ſent off, in the ſame time this way, that One Load of Hay has been loading, binding, and raking off the Outſides of it, in the next Ground, in the common way.

I will not relate the manner of making a Rick of this Seed in its Hay, of monſtrous Dimenſions, by a ſort of Maſt-pole Forty-four Feet high, with a Ten Feet Crane at the Top, which made the ſame Expedition; becauſe I think, that where ſuch a Quantity is, *Dutch* Barns with moving Roofs are better. Such a Rick is troubleſome to thatch, and the Wind has more Power to blow the Thatch off ſo high in the Air, than if it were lower. Neither would I adviſe any one to reſerve much more St. Foin for Threſhing, than his Barn will contain; becauſe tho' ſometimes it brings the greateſt Profit by Threſhing, yet ſome Years 'tis apt to be blighted.

I have been told by my Neighbour, that he had a Crop of Five Quarters of St. Foin Seed on an Acre; but the moſt Profit that ever I took notice of, was on half an Acre, which was drill'd very thin, and had no Crop of Corn with it; by which Advantage it produc'd a good Crop of Seed the next Year after it was planted, and the Third Year this Half-acre produc'd (as was try'd by a Wager) within a Trifle of Two Quarters of Seed, which was ſold for Two Pounds and Ten Shillings: The threſh'd Hay of it was ſold in the Place for One Pound, and Two Quarters of Chaff ſold for Twelve Shillings; in all Four Pounds and Two Shillings. There was alſo a very good Aftermath, which was worth the Charges of Cutting and Threſhing: So that the clear Profit of the One Year of this Half-acre of Ground amounted to Four Pounds Two Shillings: And it was remarkable, that at the ſame time the reſt of the ſame Field, being in all Ten Acres, had a Crop of Barley ſown on Three Plowings, which (the Summer being dry) was offered to be ſold at One Pound *per* Acre.

I believe the greateſt Part of the St. Foin that is ſown, is ſpoil'd by being indiſcreetly fed by Sheep (*b*); which Damage is occaſion'd merely by ſuffering them to continue feeding it too long at a time, eſpecially in the Spring; for then the Sap moves quick, and muſt be depurated by the Leaves; and as the Sun's nearer Approach accelerates the Motion or Ferment of the Juices, more *Pabulum* is receiv'd by the Roots; but, for want of Leaves to diſcharge the Recrements, and enliven the Sap with nitro-aereous Particles (the Sheep devouring the Buds continually as faſt as they appear), the St. Foin's vital Flame (if I may ſo call it) is extinguiſh'd; the Circulation ceaſing, the Sap ſtagnates, and then it ends in Corruption (*c*). But let the Sheep eat it never ſo low, in a ſhort time, without continuing thereon, or cropping the next Buds which ſucceed thoſe they have eaten, the Plants will recover and grow again as vigorouſly as ever; and if with a Spade, in the Winter, you cut off the St. Foin Heads an Handful deep, and take them away, together with their upper Earth, the Wound in the remaining Root will heal, and ſend out more Heads as good as thoſe cut off, if thoſe ſecond Heads be preſerv'd from Cattle, until they attain to a Bigneſs competent to bear Leaves ſufficient

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(*b*) I never ſuffer Sheep to come upon St. Foin, except betwixt Mowing-time and *All-Saints*. And there is ſo much Danger of ſpoiling St. Foin by the Fraud of Shepherds, that I knew a Gentleman that bound his Tenant never to ſuffer any Sheep to come thereon; and by this means his St Foin continued in Perfection much longer than is uſual, where St. Foin is ſuffer'd to be Fed by Sheep.

(*c*) Natural Graſs is not kill'd by conſtant Feeding, becauſe no ſort of Cattle can bite it ſo low as to deprive it of all its Leaves; and 'tis, like Eels, more tenacious of Life than the reſt of its Genus, and will ſend out Leaves from the very Roots when reverſed, as is too often ſeen where turffy Land is plow'd up in large Furrows.

cient for the Uſe of the reviving Plants: Nay, I have ſeen Plants of St. Foin cut off in the Winter a Foot deep, and the Earth of that Depth taken away; and the remaining Root recover'd, and grew to an extraordinary Bigneſs: But this was preſerv'd from Cattle at firſt.

I eſteem St. Foin to be much more profitable than Clover, becauſe St. Foin is never known to do any perceivable Damage to the Corn amongſt which 'tis planted; but Clover often ſpoils a Crop of Barley (*a*); and I have known, that the Crop of Barley has been valued to have ſuffer'd Four Pounds *per* Acre Damage, by a Crop of broad Clover's growing in it in a wet Summer: In a dry Summer both ſorts of Clover are apt to miſs growing; and if it does grow, and the next Summer (wherein it ought to be a Crop) prove very dry, it fails on moſt ſorts of Land, tho' it was vigorous enough to ſpoil the Barley the Year it was ſown; at beſt, 'tis of but very ſhort Duration, and therefore is not to be depended on by the Farmer, for maintaining his Cattle, which the broad Clover will alſo kill, ſometimes by cauſing them to ſwell, unleſs great Care be taken to prevent it. The broad Clover is eſteem'd a foul Feed for Horſes. The Hop Clover is gone out of the Ground ſooner than the broad Clover; I never knew it cut more than once: Indeed Cattle are never ſwollen by feeding on it; but then it affords but very little Feeding for them, except the Land whereon it grows be very rich.

St. Foin is obſerv'd to enrich whatever Ground 'tis planted on, tho' a Crop be taken off it yearly.

(*a*) But this Damage may be prevented by drilling the Clover after the Barley is an Handful high or more; for then the Barley will keep it under, and not ſuffer it to grow to any conſiderable Bigneſs till after Harveſt; nor will this Drill, being drawn by Hand, do any Damage to the Barley.

Poor Slate Land *(a)*, when it has borne ſown St. Foin for Six or Seven Years, being plow'd up, and well till'd, produces Three Crops of Corn; and then they ſow it with St. Foin again.

Rich Arable Land was planted with it, and mow'd annually with very great Crops ('twas drill'd in Nine-inch Rows, with Six Gallons of Seed to an Acre; One Crop of it was ſold at Four Pounds *per* Acre): This, after about Seven Years, and in full Perfection, was plow'd up by a Tenant, and continued for many Years after ſo rich, that, inſtead of dunging or fallowing it for Wheat, they were forc'd to ſow that upon Barley-ſtubble, and to feed the Wheat with Sheep in the Spring, to prevent its being too luxuriant.

But 'tis to be noted, that the Land muſt be well till'd at the Breaking up of old St. Foin, or elſe the Firſt Crops of Corn may be expected to fail: For I knew a Tenant, who, the laſt Year of his Term, plow'd up a Field of St. Foin, that would have yielded him Three Pounds *per* Acre; but, thinking to make more Profit of it by Corn, he ſow'd it with White Oats upon once Plowing; and it proving a dry Summer, he loſt his Plowing and Seed; for he had no Crop of Oats, and was forc'd to leave the Land as a Fallow to his Succeſſor.

Many more Inſtances there are of this Failure of the Crop of Corn after St. Foin has been broken up, and not well till'd.

(*a*) The Poverty of this ſort of Land, lying upon Slate or Stone, generally proceeds from the Thinneſs of it; and, if it were thicker, it would be good Land: Much of this Earth, being diſperſed among the Crannies or Interſtices of the Slate and Stone to a great Depth, is reach'd by the Tap-roots of the St. Foin, but cannot be reach'd by the Roots of Corn; and therefore, when conſtantly kept in Tillage, is of ſmall Value: Upon which account ſuch Land is greatly improveable by St. Foin, even when ſown in the common manner.

When St. Foin is grown old, and worn out, as 'tis ſaid to be when the artificial Paſture is gone, and the natural Paſture is become inſufficient for the Number of Plants, that are on it, to be maintained; and is ſo poor, that it produces no profitable Crop, ſo that the Ground is thought proper to be plow'd up, and ſown with Corn, in order to be replanted *(a)*; the moſt effectual way to bring it into Tilth ſpeedily, is, to plow it up in the Winter, with a Four-coulter'd Plough, and make it fit for Turneps by the following Seaſon; and if the Turneps be well ho'd, and eſpecially if ſpent by Sheep on the Ground, 'twill be in excellent Order to be ſown with Barley the following Spring; and then it may be drill'd with St. Foin amongſt the Barley.

To return to the Benefit Land receives by having been planted ſome Years with St. Foin: All the Experienc'd know, that Land is enriched by it; but they do not agree upon the Reaſon why.

They agree as to the Ὅτι, but not the Διότι.

Some are of Opinion, 'tis becauſe the St. Foin takes a different ſort of Nouriſhment to that of

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(a) Or if you perceive, that there is a competent Number of Plants alive, and tolerably ſingle; be they never ſo poor, you may recover them to a flouriſhing Condition in the following manner, without replanting: Pulverize the whole Field in Intervals of about Three Feet each, leaving betwixt every Two of them Four Feet Breadth of Ground unplow'd. When the Turf of theſe Intervals, being cut by the Four-coulter'd Plough, is perfectly rotten, one Furrow made by any ſort of Plough will hoe one of theſe Intervals, by changing the whole Surface of it. The poorer the Land is, the more Hoeings will be required; and the oftener 'tis ho'd, with proper Intermiſſions the Firſt Year, the ſtronger the St. Foin will become, and the more Years it will continue good, without a Repetition of Hoeing.

The Expence of this cannot be great; becauſe the Plough, in hoeing an Acre in this manner Nine times, travels no farther than it muſt to plow an Acre once in the common Manner.

I need not tell the Owner, that the Earth of theſe Intervals muſt be made level, before the St. Foin can be mowed.

Corn: But that I think is diſprov'd in Chapter of *Change of Species*, where 'tis ſhewn, that all Plants in the ſame Soil muſt take the ſame Food.

Mr. *Kirkham* thinks St. Foin has no collateral or horizontal Roots in the upper Part of the Ground where the Plough tills for Corn; and therefore has no Nouriſhment from that Part of the Soil which feeds the Corn. This would be a very good Account for it, were it not utterly contrary to Matter of Fact, as every one may ſee.

But ſo far it is right, that large *(a)* St. Foin draws the greateſt Part of its Nouriſhment from below the Reach of the Plough; and what Part it does receive from the Staple is overbalanc'd by the Second Crop, or After-leaſe, being ſpent by Cattle on the Ground; different from Corn, which is very near wholly maintain'd by the plow'd Part of the Earth, and is all carry'd off.

For tho' the under *Stratum* of Earth be much poorer than the upper; yet that, never having been drain'd by any ſort of Vegetables, muſt afford conſiderable Nouriſhment to the Firſt that comes there.

And beſides, in ſuch Land whoſe Poverty proceeds from the Rain's carrying its Riches too quickly down through the upper *Stratum*, the under *Stratum* muſt be the richer *(b)* for receiving what the upper *Stratum* lets paſs unarreſted.

(*a*) For large St. Foin, being ſingle, has large Roots, and very long, which probably deſcend Twenty Feet deep: Now, if we allow Four or Five Inches the Depth of the Staple, to afford a Supply equal to Two Feet below it, taking the lower Nineteen Feet Seven Inches together, upon this Computation, the Part below the Staple gives the St. Foin about Nine Parts in Ten of its Suſtenance.

(*b*) In light poor Land the Water carrying ſome impregnated Earth along with it down lower than it does in ſtrong Land, that is more tenacious of ſuch impregnated Particles, the under *Strata* of ſtrong Land are likely to be poorer than thoſe of light Land.

'Tis well known, that many Eſtates have been much improv'd by St. Foin; therefore there is no occaſion to mention Particulars. Only I will take notice, that the Firſt in *England* was one of about One hundred and Forty Pounds *per Annum*, ſown with St. Foin, and ſold for Fourteen thouſand Pounds; and, as I hear, continues, by the ſame Improvement, ſtill of the ſame Value. This is, I ſuppoſe, the ſame that Mr. *Kirkham* mentions in *Oxfordſhire*.

Another Farm of Ten Pounds *per Annum* Rent, which, whilſt in Arable *(a)*, was like to have undone the Tenant; but, being all planted with St. Foin by the Owner, was lett at One hundred and Ten Pounds *per Annum*, and prov'd a good Bargain.

If it ſhould be aſk'd, Why St. Foin is an Improvement ſo much greater in *England*, than in other Countries? it might be anſwer'd by ſhewing the Reaſon why *Engliſh* Arable is of ſo much leſs Value than Foreign *(b)*, where the Land is of equal Goodneſs, and the Corn produc'd of equal Price.

CHAP. XIII.

Of LUSERNE.

LA Luſerne is that famous *Herba Medica* ſo much extoll'd by the Antients.

The high Eſteem they had of its Uſe appears by the extraordinary Pains they beſtow'd on its Culture.

(*a*) Theſe Eſtates conſiſted of thin Slate Land; which, before it was planted with St. Foin, was valued at Two Shillings *per* Acre, and ſome Part of it at One Shilling *per* Acre (as I have been inform'd); and yet Oxen are well fatted by the St Foin it produces.

(b) 'Tis doubtleſs from the extraordinary Price of *Engliſh* Labour above that of other Countries, occaſioned by *Engliſh* Statutes being in this reſpect different from all other Laws in the World.

Its Leaves reſemble thoſe of Trefoil: It bears a blue Bloſſom very like to double Violets, leaving a Pod like a Screw, which contains the Seeds about the Bigneſs of broad Clover, tho' longer, and more of the Kidney-ſhape.

The Stalks grow more perpendicular than any of the other Artificial Graſſes that I know, ſlender, full of Knots and Leaves: 'Tis of very near an equal Bigneſs from Bottom to Top: When cut, if vigorous, the Stalks will ſpring out again from the Stubs, immediately below where the Scythe parted them; which makes them the ſooner ready for another Mowing; an Advantage which no other Graſs has.

It has a Tap-root that penetrates deeper into the Bowels of the Earth, than any other Vegetable ſhe produces.

Tho' one Luſerne-root be much more taper than another towards the upper Part of it, 'tis ſometimes ſeen, that a ſingle ho'd Plant of it has many of theſe perpendicular Roots, ſome of them ſpringing out from the very Branches of its Crown.

Its Roots are abundantly longer than the Roots of St. Foin: I have One that meaſures very near Two Inches Diameter: Thoſe which are higher than the Ground have a Bark like a Tree. Upon this account, and by its Stalks ſpringing again juſt below the Place where cut off, and by the woody Hardneſs of its Stalks, when they ſtand too long without cutting, it ſeems that Luſerne is of a Nature nearly approaching to that of a Shrub.

Luſerne is the only Hay in the World that can pretend to excel or equal St. Foin. I have known Inſtances of the pinguefying Virtue of this *Medica Hay*, that come up to the higheſt Encomiums given it by the *Romans*; which being to the Vulgar incredible, I forbear to relate, but leave to be confirm'd by the Experience of others, when it becomes frequent in *England*.

Luſerne in Graſs is much ſweeter than St. Foin, or any other Artificial or Natural Graſs. This, when ho'd, may be given to Cattle cut green, for Six Months; but then care muſt be taken to (*a*) prevent their Swelling by its Luſciouſneſs, and not to give them too much at once, until they be accuſtom'd to it.

The Quantities of Luſerne-ſeed annually imported, and ſown without Succeſs, not diſcouraging People from continuing its Importation, ſhews there is more need of a ſucceſsful way of Planting, than recommending it in *England.*

I ſhall take notice of ſome of the Reaſons why I conclude there is no Hope of making any Improvement by planting it in *England*, in any manner practis'd by the Antients or Moderns.

I wonder how any one ſhould attempt to plant it here, who has ſeen in *Columella*, and other Authors, the Deſcription of the manner the old *Romans* planted it in. They choſe out the very beſt Land, that was both *pinguis* and *putris*; they dung'd and till'd it to the greateſt Perfection, and laid it out in Beds, as we do for Onions or Aſparagus; they ſow'd it

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(*a*) The Swelling of Cattle by eating too much green Luſerne, Clover, or Turnep-leaves, happens only to ſuch as chew the Cud, becauſe they ſwallow more in leſs Time than other Cattle do; and a large Quantity of ſuch luſcious Greens being ſwallow'd by a Beaſt, fermenting to a great degree, heats and rarefies the internal Air, which by its Spring becoming too ſtrong for that Column of the Atmoſphere that enters at the Trachea, it preſſes the Lungs againſt the Thorax ſo cloſely, that the Weight of the external Column is not of Force to open their Veſicles, and then the Circulation of the Blood is ſtopt, and the Beaſt is ſtrangled.

Moſt Farmers know how to prevent the Swelling, ſo that now-a-days it ſeldom happens; but when it does, there is an effectual way of curing it, if taken in time: They cut a Hole into the Maw near the Back in a proper manner, whereat the rarefied Air ruſhes out, and the Lungs again perform their Action of Reſpiration.

very thick, for that miſerable Reaſon of enabling it by its Thickneſs the better to kill the Graſs. The Beds being harrow'd very fine before Sowing, which was in the End of *April*, the Seed required to be ſpeedily cover'd, leſt the Sun's Heat ſhould ſpoil it. But with what Inſtrument muſt it be cover'd? For, after Sowing, the Place muſt not be touch'd with Iron. *At medica obruitur non aratro, ſed ligneis raſtellis.* '*Medica*-ſeed is cover'd, not with the 'Plough, but with little (or rather light) wooden Har-'rows.' Two Days Work (of a Team) were ſpent on this Harrowing of one Acre. Some time after it came up, they ſcratch'd it again and again with the ſame wooden Inſtruments: This was call'd Sarrition: Then by Runcation they weeded it over and over, *Ne alterius generis herba invalidam medicam perimat.* 'Leſt 'other Graſs ſhould kill it whilſt it was weak.' The Firſt Crop they let ſtand till ſome of the Seed ſhatter'd, to fill the Ground yet fuller of Plants: After that they might cut it as young as they pleas'd; but muſt be ſure to water it often after cutting. Then after a few Days, when it began to ſpring, they repeated their Runcation; and ſo continuing to weed out all manner of Graſs for the Firſt Two or Three Years, it uſed to bring Four or Six Crops a Year, and laſt Ten Years.

Engliſh Gardeners make Forty Pounds of an Acre of Aſparagus, or Cabbage-plants, with half the Labour and Expence that was beſtow'd on an Acre of *Roman Medica.*

We know not the Price Hay and Graſs were at in *Italy*, whilſt the *Roman* Empire was in its Glory, and *Rome*, then the Metropolis of the World, drew the Riches of all Parts thither; its Price muſt be then very high.

And the *Romans* had not only Servants, but plenty of Slaves, for whom they had ſcarce ſufficient Employment: This might leſſen the Expence of this tedious Method of planting, and ordering the *Medica.* But when the *Romans* were brought down to the Level of other Nations, and in Danger of being Slaves, inſtead of having them; and the Lands of *Italy* came to be cultivated by *Italian* Hands only; they found ſomething elſe more neceſſary to employ them in, than the Sarritions, Runcations, and Rigations of the *Medica.* Their Labour being beſtow'd in getting Bread for themſelves, they ſubſtituted other artificial Graſſes of more eaſy Culture, in the room of *Medica*, for the Food of their Cattle. They were ſo bigotted to all the Superſtitions of their Anceſtors, that they were content to loſe the Uſe of that moſt beneficial Plant, rather than attempt to cultivate it by a new, tho' more rational Method, when they were become unable any longer to continue it by the old.

Thus, as I take it, Superſtition has chaſed *Medica* from the *Roman* Territories; and ſo little of it is planted there, that beyond the *Alps* I could not find one whole Acre of it.

Luſerne makes a great Improvement in the South of *France:* There, when their low ſandy Land is well prepar'd, and very clean, they ſow it alone, in *March*, and at *Michaelmas*, as we do Clover: Their ſowing it at thoſe Seaſons is of a double Advantage: Firſt, It ſaves the Labour of watering it, which would be impracticable for ſo many Thouſand Acres, as are there planted. Secondly, Thoſe Seaſons being much moiſter than that wherein the *Romans* ſow'd it, the Grub has Opportunity of eating more of it at its firſt coming up; and often the Froſt kills ſome of it. By theſe Advantages the Ground is leſs overſtock'd.

The Summers there are much drier than in *Italy*, ſo that the Sun ſcorches up the natural Graſs, and ſuffers it not to come to a Turf till after ſome Years; and therefore has leſs need of Weeding.

But as that natural Graſs increaſes, the Crops of Luſerne are proportionably diminiſh'd: And tho' Luſerne is ſaid to laſt Ten or Twelve Years; yet it is in Perfection only for a very few Years. Whilſt it is at beſt on their richeſt Land, and in a kind Summer, they have at Seven Crops Ten Tuns to an Acre, as I have computed them from the Relation of ſome of the Inhabitants of *Pezenas*. This was extraordinary; for I obſerv'd, that moſt of their common Crops made a very thin Swarth.

When the Ground begins to be turffy and hard, many of the Luſerne-plants die, and the reſt ſend up very few Stalks: The People know this is the Deſtruction of it, and therefore I have ſeen ſome of them, in that Caſe, half-plow it, thinking thereby to deſtroy the Turf: This does for a time much ſtrengthen the Luſerne-plants; but it ſo much ſtrengthens the Graſs alſo, that the Turf grows the ſtronger; and then there is no Remedy but to plow it up, make the Ground clean, and replant it.

In more Northern Climates, where it rains oftener, the Ground ſooner becomes hard; and in the Land otherwiſe moſt proper for Luſerne, the Graſs grows infinitely faſter, and will be as ſtrong a Turf in Two Years, as in the hot Countries in Ten. Upon this account, about *Paris*, even near the Walls, they plow up Luſerne, and ſow St. Foin in its room, becauſe that endures Graſs and hard Ground better, tho' it brings but One Crop a Year, or Two at moſt.

And in many Places in *Frnchea Comté* and *Switzerland*, I have ſeen Luſerne in the Corners of Vineyards, not above Two or Three Perches together, which they will at any Expence have to cure their Horſes when ſick; ſince they cannot obtain, by their Culture, Quantities ſufficient to maintain them as their ordinary Food, there being too much Rain, and too little of the Sun's violent Heat, to prevent the ſpeedy Increaſe of Graſs amongſt it.

How then can we expect Succeſs in ſowing it in *England*, where Rains are yet more frequent, and the Sun is weaker? 'Tis not One Year in Ten that the natural Graſs is here ſcorch'd up. In our rich Land the Graſs comes to a Turf very ſoon, and poor Land will not by the common Sowing bring Luſerne to any Perfection, tho' no Graſs ſhould annoy it.

I have here ſeen Part of a Meadow Breaſt-plow'd, and, when the Turf was dead, dug up and planted as a Garden: After it had been drill'd with Carrots, ho'd, and made, in all Appearance, perfectly clean, it was ſown with Luſerne, which came up and flouriſh'd very well the Firſt Year, and indifferently the Second; but, after that, the Graſs came, and the Luſerne grew faint; and in Three or Four Years time there was no more left, but juſt to ſhew by here-and-there a ſingle poor Stalk, that there had been Luſerne ſown, except one Plant of it, which was cleanſed of Graſs the Third Year; and this recover'd, and ſent up abundance of Stalks for Two Years after it; and then the Graſs returning, that Plant dwindled again.

I have often try'd it in the richeſt Part of my Garden, and conſtantly find, that, however vigorouſly it grows at the Firſt, yet it ſoon declines, when the Graſs appears amongſt it, which is always the ſooner, by how much the Soil (in *England*) is richer, unleſs the Spade or Hoe prevent it.

Here have been alſo many Fields of a poorer white-iſh Soil ſown with it, which are not very ſubject to be over-run with Graſs, as the rich Land is; and tho' theſe were ſo well till'd as ſcarce any Graſs appear'd, during the many Years the Luſerne liv'd therein, yet it never grew to any Perfection here neither; nor was there any One Crop worth much more than the Cutting, it was always ſo poor, thin, and ſhort. And, by what Intelligence I can get, all

Experience proves, that every Soil in this Iſland is too rich, too poor, or too cold, for the Luſerne Improvement by the common Huſbandry.

I believe every one will be confirm'd in this, who ſhall upon full Inquiry find, that, amongſt the great Quantities which have been ſown in this Kingdom in that manner, never any of it was known to continue good and flouriſhing Three Years; and that, on the contrary, never any one Plant of it in any warm Soil, cultivated by the Hoeing manner, was known to fail here, or in any other Country, as long as the Hoeing (or Digging about it, which is equivalent) was continued to it with proper Repetitions.

A Multitude of ſuch ho'd Plants have I known, and are now to be ſeen in both poor and rich Lands: Therefore it ſeems poſſible, that Thouſands of *Engliſh* Acres may be capable, by the Hoeing Culture, to produce Crops of Luſerne every Year for an Age. For as the greater Moiſture, and leſs intenſe Heat of this Climate, are, upon the accounts mention'd, injurious to Luſerne, yet this is only to ſuch as is ſown and cultivated in the common manner, becauſe our Climate, upon the very ſame accounts, is very advantageous to ho'd Luſerne.

In hot Countries, when the Summer is drier than ordinary, the Sun ſo ſcorches it, that they have fewer and much poorer Crops, than in moiſter Summers; *viz.* only Four or Five, inſtead of Six or Seven; but, in the drieſt Summer I ever knew in *England*, ho'd Luſerne yielded the moſt Crops.

Our Summer Days are longer, have more of the Sun's Warmth, and leſs of his fiery Heat; he cheriſhes, but never burns Luſerne, or any other ho'd long Tap-rooted Plant in *England*.

The well ho'd Earth, being open, receives and retains the Dews; the benign ſolar Influence is ſufficient to put them in Motion, but not to exhale them from thence. The Hoe prevents the Turf, which would otherwiſe by its Blades or Roots intercept, and return back the Dews into the Atmoſphere, with the Aſſiſtance of a moderate Heat. So that thisHuſbandry ſecures Luſerne from the Injury of a wet Summer, and alſo cauſes the Rain-water to ſink down more ſpeedily, and diſperſe its Riches all the Way of its Paſſage; otherwiſe the Water would be more apt to ſtand on the Surface, chill the Earth, and keep off the Sun and Air from drying it: For, when the Surface is dry and open, Luſerne will bear a very great Degree of Heat, or grow with a mean one. I have ſeen this ho'd Luſerne, in a ſheltry Place of my Garden, ſo much grown in a mild Winter, as to be meaſured Fourteen Inches and an half high at *Chriſtmas*; and a very large ſingle Plant of it, which had not been ho'd for Two Years before, was laid bare by digging out the Earth all round it a Foot deep, to obſerve the manner of its Tap-root; and then the Earth was thrown in again, and the Hole fill'd up. This was on the Twenty-ſeventh of *September*. Upon this mellowing of the Soil about it, it ſent out more Stalks in *October*, than it had done in the whole Summer before; they grew very vigorouſly, until a great Snow fell in *December*, which alſo preſerv'd the Verdure of them, till that was melted away, and a black Froſt came after it, and kill'd thoſe Stalks. It is probable this Plant ſent out immediately new fibrous horizontal Roots, which did grow apace to extract the Nouriſhment from this new-made Paſture, in proportion to the quick Growth of the Stalks, which in Summer have been meaſured, and found to grow in Height Three Inches and an half in a Night and a Day; this being almoſt One Inch in Six Hours.

And it has been my Obſervation, that this Plant, in hot and cold Countries, thrives both with a much greater, or leſs Degree of Heat and Moiſture, when it is ho'd; for if it has Plenty of Nouriſhment, which

Hoeing always gives it, a very little Heat above, and the Moiſture alone (which is never wanting to the deep Tap-root) ſuffice, and that Plenty of Food enables it the better to endure the Extremes of either Heat or Cold.

We need not much apprehend the Danger of *Engliſh* Winters; for Luſerne will endure thoſe which are more rigorous. In the Principality of *Neufchâtel* the Winters are ſo ſevere, as to kill all the Roſemary left abroad; yet Luſerne ſurvives them there: This proves it more hardy than Roſemary, which is planted for Hedges in *England*; and here is ſcarce twice in an Age a Froſt able to kill it.

I have one ſingle Luſerne-plant in a poor Arable Field, that has ſtood the Teſt of Two-and-twenty Winters, beſides the Feeding of Sheep at all Seaſons, and yet remains as ſtrong as ever. What Quantity of Hay this Plant yearly produces, cannot be known, becauſe at thoſe times that Cattle are kept from it, the Hares conſtantly crop it, being ſweeter than any other Graſs.

But this happens to be fortunately ſituate, where 'tis not altogether deſtitute of the Benefit of Hoeing. 'Tis in an Angle, where, every time the Field is till'd, the Plough goes over it in turning from the Furrows of one Land and one Head-land; but it is after the Plough is lifted out of the Ground, and turn'd up on one ſide, ſo that the Share only breaks the Turf very ſmall all round it, without plowing up the Plant: Yet it has eſcaped it ſo narrowly, that the Fin of the Plough-ſhare has ſplit it into Four Parts, Three of which remain, and grow never the worſe; but the Fourth is torn off, and the Wound heal'd up.

By the extreme hard Winter that happen'd about the Year 1708. or 1709. ſome of the Luſerne in *Languedoc* was kill'd: Yet this was no Argument of its Tenderneſs, but rather the contrary; becauſe then all the Olive-trees and Walnut-trees were there kill'd, tho' the greateſt Part of the Luſerne eſcaped unhurt: And I did not hear One Walnut-tree was kill'd that Winter in *England*. Perhaps thoſe in *France*, having been accuſtom'd to much hotter Summers, were unable to endure the Rigour of the ſame Winter, that could do no Harm to the ſame Species in *England*, where our Winters do not ſeem to exceed ſome of theirs in Cold, ſo much as their Summers do ours in Heat. And ſince the Extremes are not ſo far aſunder here, the ſame Degree of Cold may to our Plants ſeem tepid, which to thoſe in *Languedoc* muſt ſeem rigorous, differing in a more remote Degree from the oppoſite Extremity of Heat in Summer.

And, beſides the Difference of Heat and Cold in different Climates, there is another more neceſſary to be obſerv'd; and that is, the Difference of the Hardineſs in different Individuals of the ſame Species: The ſame Froſt that kills a faint languiſhing Plant of Luſerne, will be deſpis'd by a robuſt one, which, being well fed by the Hoe, becomes a Giant cloath'd and fenc'd with a thick Bark, that renders it impregnable againſt all Weather; its Rind is to it a Coat of Mail or Buff, impenetrable by Froſt: But the unho'd is generally ſmall and weak; its thin tender Bark expoſes it almoſt naked to the Froſt; it being, for want of a ſufficient Paſture, ſtarv'd and half-dead already, 'tis the more eaſily kill'd by the Cold.

I formerly liv'd ſome Years in *Languedoc*, where are many Hundred Acres of Luſerne; and I never could find a very large Plant amongſt it, unleſs in ſuch Pieces as had been plow'd up, till'd, and ſown with Corn: Here indeed thoſe Plants that remain'd (as always ſome would do) grew to an extraordinary Bulk; and One of thoſe ſingle till'd Plants did ſeem to produce a greater Quantity of Stalks, than Twenty of ſuch as had not been plow'd up; and as there were no large Plants amongſt the unplow'd, ſo there were no ſmall amongſt the plow'd ones. The ſame thing has been obſerv'd in all other Places where Luſerne has been plow'd (*a*).

And in *Wiltſhire* ſeveral Grounds of it ſtood ſome Years without ever coming to a Subſtance to be of any Value, tho' the Land was whitiſh, and ſcarce any Graſs appear'd amongſt the Luſerne; and therefore its Poorneſs was thought to proceed from the Soil's being improper; but when it had been broken up, and ſown ſeveral Years with Corn, and afterwards lain down with St. Foin, all the Luſerne-plants which remain'd (and they were many) grew large and ſtrong, ſhooting up a Yard in Height ſoon after the St. Foin was cut; and if there had been a competent Number of them undeſtroy'd by the Plough, they would have yielded Crops of an extraordinary Value, where before Plowing it grew but few Inches above the Ground.

It ſeems that in this ſort of Land the Earth grows ſtale, ere the Luſerne arrives at a Tenth Part of its Stature: But this is moſt remarkable, that Tillage transforms thoſe Luſerne-plants from Dwarfs to Giants; and then they are able to contend with, if not conquer, ſo ſtrong Plants as St. Foin is, tho' before Plowing they were unable to reſiſt the Depredations of a few hairy Spires of Graſs.

Since Tillage can thus recover Luſerne, after it has long languiſh'd in the loweſt Ebb of Life, and reſtore it to Health, Youth, and Vigour, and augment its Stature even after it has paſs'd the Age of its full Growth; to what Bulk would it arrive, regularly planted, and ho'd from its Infancy to Maturity, without any Check to ſtint it!

We can never know how poor a Soil will bear this Plant, unleſs it be try'd by the Hoeing Culture.

For 'tis wondrous how ſo great a Man as Dr. *Woodward* ſhould imagine, that Difference of Soil

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(*a*) This Plowing is a Hoeing to the Luſerne.

ſhould be the Reaſon why Apples in *Herefordſhire*, and Cherries in *Kent*, ſucceed better than in other Places, when in truth they are ſeen to proſper as well almoſt all over *England*, where planted, cultivated, and preſerv'd.

I believe Plants are more alter'd as to their Growth, by being cultivated or not, than by Change of Climates differing in very many Degrees of Latitude. I ſay, in their Growth, not always in their Fruit; for tho' a Peach-tree, well cultivated in a Standard, will grow here vigorouſly, and be very beautiful; yet its Fruit will be of little Value, unleſs it be planted againſt a good Wall: So Luſerne, unleſs cultivated upon a well expoſed Gravel, will yield little Seed in *England*.

The Soil to plant it on is either an hot Gravel, a very rich dry Sand, or ſome other rich warm Land, that has not an under *Stratum* of Clay, nor is too near the Springs of Water; for, if the Earth below be of a cold Nature, which I take to be occaſion'd by its holding of Water, the Luſerne will not long proſper therein, of whatever Sort the upper *Stratum* of Earth may be: This may be gueſs'd at by the Vegetables a Soil naturally produces, as Fern, and the like; which, Mr. *Evelyn* obſerves, do indicate a Soil ſubject to Extremities of Heat and Cold; and condemns ſuch a Soil as accurſed. I agree to that Sentence, as far as relates to Cold; but am not ſatisfy'd of its abounding with Heat; and I am ſure I know ſome Land very ſubject to Fern, which is very far from being barren, when well cultivated, and well ſuited with Vegetables; but, from among theſe, Luſerne muſt be excluded.

Luſerne in hot Countries grows beſt near Rivers, where its Roots reach the Water, which helps to mitigate the exceſſive Heat of the Climate; but here the Heats are ſo moderate, that if Luſerne-roots are in Water (for 'tis that that makes Earth cold) it diminiſhes

miniſhes too much the juſt Proportion of Heat, which Luſerne requires.

The natural Poorneſs of an hot Gravel may be compenſated by Dung, more Heat, and the Benefit of the Hoe.

The natural Richneſs of the other ſorts of Land being increaſed by hoeing and cleanſing it from Graſs, Luſerne will thrive therein with the leſs Heat; for what the Soil wants of one of theſe Two Qualities, muſt be made up with the other; and it has grown high in ho'd rich Ground at *Chriſtmas*, when that in Land of an hotter Nature, but poorer, has not been able to peep out, for want of more Nouriſhment: So, if rich Land be clayey, very wet and cold, tho' very rich, it requires much Heat, for as high a Growth of Luſerne at *Midſummer*.

The beſt Seaſon of planting it in *England* is in *April*, after the Danger of Froſt is over; for a ſmall Froſt will deſtroy the whole Crop, when the Plants firſt appear; and too much Wet, with cold Weather, will rot the Seeds in the Ground; ſo that about the Middle of *April* may be generally eſteemed as the beſt Seaſon for ſowing this Seed.

The ho'd Plants of Luſerne having larger Roots, and yielding more Crops than thoſe of St. Foin, Reaſon ſeems to require, that the Number of the former be leſs.

But, on the other hand, if we conſider, that as the Luſerne-roots exceed the St. Foin in Bigneſs, ſo they alſo do in Length, by as great a Proportion; being generally leſs taper, and as they go deeper, they have more Earth to nouriſh them; they alſo require a better Soil, and more frequent Aids from the Hoe; and, by their extraordinary quick Growth, receive a ſpeedier Relief from it, than the Roots of St. Foin do.

Thus, if by reaching deeper in a better Soil, and being more ho'd, Luſerne receives, from a ſquare

Perch of Ground, Nouriſhment in a proportion double to that whereby its Roots exceed thoſe of St. Foin in Bigneſs, then I do not ſee why we ſhould not leave the Number of Luſerne-plants double to the Number of thoſe we leave in St. Foin.

But if the Exceſs of Nouriſhment were no more than the Exceſs of Bigneſs of Roots, I think an equal Number of Plants ſhould be left in Luſerne, and in St. Foin: Yet ſince the hot or cold Conſtitution of a Plant, and alſo the Quantity it can produce, ought to be conſider'd, as well as its Bulk, in relation to the Nouriſhment it requires, more Trials are neceſſary for determining the exact Number of Luſerne-plants proper to be plac'd on a ſquare Perch, than have been hitherto made.

Perhaps it will be thought heterodox to maintain by any Arguments, that to err in falling ſomewhat ſhort of the juſt Number, is not of worſe Conſequence, than exceeding it.

Where they ſtand at Four or Five Inches aſunder in the Rows, 'tis obſerv'd, that tho' the Intervals betwixt the Rows be wide, yet the Plants are much the larger, and produce more that ſtand in the outſide Rows (the Ground without being clean); and eſpecially thoſe at each End of the outſide Rows, that is, the Corner-plants, are largeſt of all. I need not ſay, that had all the other Plants as much Room and Tillage as the Corner ones have, they would be as large, and produce each as much Hay; for thoſe which ſtand perfectly ſingle in Places by themſelves, are ſeen to be larger, and produce more, than thoſe Corner ones; and of the larger and longer Roots our Stock does conſiſt, the more Nouriſhment they are capable of taking, as has been ſhewn. Where ſome Plants of the Luſerne have been planted Two Feet aſunder, in poor dry Land, which was kept clean from Weeds, and frequently digged, each Plant has ſent forth upward of Three hundred Stalks, and theſe have been Six or Seven Inches high by the Middle of *March*.

And it muſt be likewiſe obſerv'd, that the Crop will be produc'd in proportion to the Nouriſhment it receives; for if the moſt gigantic Luſerne-plant, which, when pamper'd by the Hoe, has made a Produce more like a Tree than an Herb, remains a few Years without that or ſome equivalent Culture, it will by little and little ceaſe to produce more than a few poor ſickly Stalks, juſt to ſhew its Species; and then, if this Culture be repeated, will recover its priſtine Strength, and yield as great a Crop as ever; but, if that be longer omitted, will die: The Vaſtneſs of its Root avails nothing, unleſs it has Food in proportion to it.

Hence it appears, that the moſt fatal Diſeaſe incident to Luſerne is ſtarving; and that rarely ſuffers any of its Plants to arrive at the full Period of their Growth or Age; it prevents their Fertility even in the Prime of their Youth, and kills them before they have liv'd out Half, or perhaps the Tenth Part, of their Days. How long its Life might otherwiſe be, nobody knows, unleſs a Plant could be found to die when well fed; for when it is, 'tis ſo tenacious of Life, that, I am told, beheading will not diſpatch it (*a*).

'Tis therefore neceſſary, that our Rows be plac'd at ſuch a Diſtance, as that their Intervals may be wide enough for the Hoe-plough to raiſe an artificial Paſture, ſufficient to ſuſtain the Number of Plants in them.

Whoever ſhall make Trials of this Huſbandry (for that is all I propoſe to others), I would adviſe them to begin with Rows that have Intervals of Thirty-three Inches; for, if they begin with much

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(*a*) But I have cut off the Heads of ſome myſelf to try, and could not find that any one would ſprout again, tho' *St. Foin* will; perhaps I tried at the wrong Seaſon.

narrower Diſtances, they may be by that means diſappointed of Succeſs: But tho' they ſhould afterwards find a Way to hoe them at ſomewhat nearer Diſtances; yet the Loſs of a few Perches of Ground would not be much; neither can they be wholly loſt, ſince the Roots of theſe Plants may be prov'd to extend much farther horizontally, than from Row to Row at that Diſtance. And the wider the Intervals are, the more Earth will be till'd in a Perch of Ground; becauſe Six Rows, which will be therein at Thirty-three Inches Diſtance, will admit the Hoe-plough to till more Earth, than Nine Rows at Twenty-two Inches Diſtance from each other: And, beſides, 'tis not proper, that, every time of hoeing, the Plough ſhould come very near to the Plants, unleſs when Graſs comes amongſt them; and then they may, in Thirty-three Inch Spaces, be perfectly cleanſed in this manner; *viz.* Plow a good Furrow from each Side of every Row; and then with Harrows, or other Inſtruments proper for that Purpoſe, going croſs them, you will pull out both Earth and Graſs from betwixt the Plants; then, after a convenient Time, plow theſe Furrows back again to the Rows; this will in a manner tranſplant the upper Part of the Roots, and bury the Graſs, tho' it be not dead, by lying open to be dry'd by the Sun: Then harrow the Ground to break it more, and to level it, and go once over it with a very light Roller, to the end that the Hay may be raked up the cleaner.

I am aware of the common Prejudice, which is, that People, when they have never ſeen a Plantation of theſe Plants in Perfection, are apt to form to themſelves the Idea of ſuch ſmall ones as they have been uſed to ſee; and thence imagine it impoſſible that this (tho' a double) Number ſhould be ſufficient to make a Crop. But they might, with equal Reaſon, imagine the ſame of Apple-trees at a Year's Growth, which are leſs than theſe at the ſame Age;

and ſo plant a Thouſand Trees in the Room proper for one. The Antients direct the planting of Seventeen *Cytiſus* Plants in a Perch of Ground; and I do not believe, that ever thoſe Seventeen could yield a Crop equal to Two hundred Twenty-four Luſerne-plants; for as many Ounces of Hay as each of theſe yields, ſo many Ton of Hay will one Crop of an Acre produce: Thus by weighing the Product of one Plant (ſuppoſing them all equal) the Quantity of the Crop may be determin'd, and prov'd greater than Fancy from their Number repreſents.

	s.	d.
April 14. One ſingle unho'd Plant of Luſerne had Thirty-one Stalks, which, by Silver Money, weigh'd green —	23	0
24. The ſame dried to Hay, weigh'd	6	6
14. The Stalks of one ſingle ho'd Luſerne-plant green, weigh'd —	56	0
24. The ſame dry'd —— —	14	6
14. Eighteen Inches in Length of a Row, being Five indifferent Plants, weigh'd green one Pound and an half *Avoirdupois*		
24. Dry'd to Hay, it weigh'd —	28	6
25. One Foot of an ho'd Row, being One hundred and Sixty Stalks of Two Luſerne-plants of Six or Seven Years old, weigh'd Two Pound green —		
But the ſame dry'd, to the 9th of *May*, weigh'd no more than —— —	31	6

Which laſt is about Three Tons to an Acre.

This I am certain of, that the leaſt competent Number of Plants will bring the greateſt Number of Crops; ſince I ſee the Stalks of a ſingle ho'd Plant grow higher in Fifteen Days, than one amongſt near Neighbours does in Thirty Days.

The greateſt Difference between the Culture of this and St. Foin is, that Luſerne-rows ſhould be more grown, before the Plants be made ſingle in them by the Hand-hoe, leſt the Fly ſhould deſtroy ſome afterwards, and then they might become too thin. For Luſerne is ſometimes eaten by the Fly, as Turneps are, tho' St. Foin be never liable to that Misfortune, if ſown in a proper Seaſon. Luſerne muſt alſo be more frequently ho'd (*a*), in ſome Proportion to the more frequent Crops it produces.

I ſhall not go about to compute the Difference of Expence beſtow'd in the *Roman* Culture and in this; yet it will appear theirs was incomparably more chargeable, and that that Exceſs of Charge was occaſioned by their Error in the Theory of Huſbandry.

They ſow'd it ſo thick, that the Plants muſt needs be very ſmall; and when Ten of them were no bigger than one good ſingle ho'd Plant would have been, in the ſame Space of the Earth's Surface, they could have but a Ninth Part of the Earth's Depth, which the one would have had. The Defect of Depth muſt be therefore made up, in ſome meaſure, by the extraordinary Richneſs of the Surface. Upon this Account few Lands were capable of bearing *Medica*. Their ſowing it ſo late made the firſt Waterings neceſſary; and the Shortneſs of the Roots required the repeated Rigations, after the Crops were cut: For

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(*a*) The Hoe-plough is the Inſtrument to bring it to Perfection; but then I doubt it muſt lie ſtill ſome Years, leſt the plow'd Earth injure the Hay that is made upon it; and when it is come to a Turf, and the Luſerne wants renewing, the Four-coulter'd Plough is the only Inſtrument that can prepare the Turf to be kill'd, and cure the Luſerne; which Plough muſt be uſed in the following manner: Turn its Furrows toward one Row, and from the next; that is, plow round one Row, and that will finiſh Two Intervals, and ſo on; and the next Plowing muſt be towards thoſe Rows, from whence they were turn'd the firſt time; take care the firſt Furrows do not lie long enough on the Rows to kill the Plants, which will be much longer in Winter than in Summer. But you may leave every Third or Fourth Interval unhoed for making the Hay on, which will be yet more beneficial, if the Swarths in mowing ſhould fall thereon. This unhoed Interval may be plowed when there is occaſion, and another left in its ſtead.

Columella ſaith in *Lib.* ii. *Cap.* 11. *Cum ſecueris autem, ſæpius eam rigato.* But had it been cultivated by the hoeing Method, the Tap-roots would have deſcended as deep as a Well, and, from the Springs below, have ſent up Water to the Plants, beſides what the Hoe would have cauſed the horizontal Roots to receive from Dews at the Surface above. At how much a cheaper Rate Water is ſupply'd by theſe means, than by carrying it perhaps a great Way, and then ſprinkling it by Hand over the Beds, which were made Ten Feet wide between Path and Path for that Purpoſe, let any one judge; as alſo what a laborious Taſk it was to pick out the Graſs with Fingers from amongſt it, in the hard dry Ground in the Summer, after mowing the Crop, as *Columella* directs in his forement, ion'd Chapter, which the Horſe-hoe would have done with Eaſe, at a Twentieth Part of that Expence. However, ſince they ſaw the *Medica* was as impatient of Graſs as the Vineyards were, 'tis a Wonder they did not give it the ſame Culture with the *Bidens*, which would have been much better and cheaper, than to cleanſe the *Medica* with Fingers. Indeed Fingers were made before the *Bidens*; but ſure the Effect of its Uſe, in raiſing Juices to the Vine, had inſpired the *Romans* with more judicious Speculations, than to give that for a Reaſon why they ho'd the *Medica* with their Fingers, rather than with the *Bidens*.

Oh! But this was made with Iron, and *Medica* had, in thoſe times, an Antipathy to Iron; and after it was ſown, the Place muſt not be touch'd by that Metal; therefore the Seed muſt not be cover'd with a Plough, nor with Iron Harrows. But if they had made Trials enough, to know that half an Inch was a proper Depth to cover this Seed at, theſe *Virtuoſi* would have been convinc'd, that it had no leſs Antipathy to theſe Inſtruments, of what *Matter* ſoever they were made, if they bury'd it Five or Six

Inches deep, which the Plough muſt do, and the Weight of Iron Harrows in ſuch fine Ground, not much leſs. Had the Plough been all of Wood, the Furrow would have lain never the lighter upon the Seed; and if the wooden Harrows had been loaded with a Weight capable of preſſing it down as deep, it would have been no more able to riſe, than if it had been buried with Iron Harrows: This *Columella* ſeems to be ſenſible of, when he ſays, *Raſtellis ligneis*; *viz.* That it was not ſufficient for them to be made of Wood, unleſs they were diminutive; for then they were light ones. 'Tis probable the Plough ſuffer'd none to come up, and the heavy Harrows very few, tho' perhaps Plants enough, had they calculated what Number were ſufficient: But unleſs the Ground were cover'd with them at firſt, it ſeems they had not Patience to wait till the Plants grew large enough, to fill it with a bare competent Number; and thought it not worth while to weed and water, what they fanſied to be an inſufficient Number. 'Twas expected that the Thickneſs of the Plants ſhould help to kill the Graſs: Yet upon due Obſervation 'tis found, that when their exceſſive Numbers have brought a Famine amongſt them, they are forc'd to prey upon one another; and tho' the ſtronger ſurvive, yet even thoſe are ſo weaken'd by Hunger, that they become the leſs able to contend with Graſs, whoſe good Fortune it was, that Superſtition would not permit the *Romans* to interpoſe, by attacking it with Iron Weapons.

I hope theſe Hints may be improv'd for the Abolition of old Errors, and for the Diſcovery of new Truths; to the end that Luſerne may be planted in a more reaſonable Method than has been commonly practis'd: And when the Theory is true, 'tis impoſſible the Practice ſhould be falſe, if rightly apply'd; but if it fail of Succeſs, the Event will be a

Proof either of a Miſapplication, or that the Theory is falſe.

Luſerne ſhould be order'd for Hay in the ſame manner, as is directed for St. Foin in the foregoing Chapter: But it muſt be obſerv'd, that Luſerne is more worſted by being ſuffer'd to ſurvive its Virginity before cutting; and therefore the richeſt and moſt nouriſhing Hay is cut whilſt the Stalks are ſingle, without any collateral Branches ſhooting out of them; and when they are ſo, neither Bloſſoms nor even their Buds appear. But of that ſown in the old Faſhion, the laſt Crops, for want of a new Supply of Nouriſhment, grow ſo ſlowly, that ere it is high enough to be cut, the Bloſſoms are blown out, and the Stalks tho' very ſmall, are become *woody*, *hard*, and *dry*, and make the Hay nothing near ſo nouriſhing as that of the firſt Crops.

But in that which is ho'd, the laſt Crops of it will, by virtue of the greater Quantity of Nouriſhment it receives, grow faſter, and be of an Height fit to cut before bloſſoming, and thence being as young and vigorous, make as good Hay as the firſt Crops; ſo that Hoeing does not only procure more and larger Crops, but alſo better Hay.

This is moſt certain, that unleſs we can keep our Luſerne pretty clean from natural Graſs, we cannot expect it to ſucceed, let the Soil be never ſo proper.

CHAP. XIV.

Of Change of SPECIES.

I. *That Plants of the moſt different Nature feed on the ſame Sort of Food.*

II. *That there is no Plant but what muſt rob any other Plant within its Reach.*

III. *That a Soil which is proper to one Sort of* Vegetable *once, is, in reſpect of the Sort of Food it gives, proper to it always.*

IF any one of theſe *Three Propoſitions* be true, as I hope to prove all of them are, then it will follow, that there is no need to change the Species of *Vegetables* from one Year to another, in reſpect to the different Food the ſame Soil is, tho' falſely, ſuppoſed to yield *(a)*.

The common Opinion is contrary to all theſe (as it muſt be, if contrary to any one of them): And ſince an Error in this fundamental Principle of *Vegetation* is of very ill Conſequence; and ſince Dr. *Woodward*, who has been ſerviceable in other reſpects (*b*) to this Art, has unhappily fallen in with the Vulgar in this Point; his Arguments for this Error require to be anſwer'd in the firſt Place.

(*a*) For if all Plants rob one another, it muſt be becauſe they all feed on the ſame Sort of Food; and, admitting they do, there can be no Neceſſity of changing the Species of them, from one Soil to another; but the ſame Quantity of the ſame Food, with the ſame Heat and Moiſture which maintains any Species one Year, muſt do it any other Year.

(*b*) By proving in his Experiments, that Earth is the *Pabulum* of Plants.

The Doctor ſays, (*c*) ‘ It is not poſſible to imagine
‘ how one uniform, homogeneous Matter, having its
‘ Principles, or original Parts, all of the ſame Sub-
‘ ſtance, Conſtitution, Magnitude, Figure, and Gra-
‘ vity, ſhould ever conſtitute Bodies ſo egregiouſly
‘ *unlike*, in all thoſe reſpects, as Vegetables of dif-
‘ ferent Kinds are; nay, even as the different Parts
‘ of the *ſame* Vegetable.

‘ That there ſhould be that vaſt Difference in
‘ them, in their ſeveral Conſtitutions, Makes, Pro-
‘ perties, and Effects, and yet all ariſe from the very
‘ ſame Sort of Matter, would be very ſtrange.’

Anſwer. ’Tis very probable, that the terreſtrial Particles which conſtitute *Vegetables*, tho’ inconceivably minute, may be of great Variety of Figure, and other Differences; elſe they could not be capable of the ſeveral Ferments, &c. they muſt undergo in the Veſſels of Plants. Their Smalneſs can be no Objection to their Variety, ſince even the Particles of Light are of various Kinds.

But as the Doctor aſſerts, ‘ That each Part of the
‘ ſame *Vegetable* requires a peculiar ſpecific Matter
‘ for its Formation and Nouriſhment; and that there
‘ are very many and different Ingredients to go to
‘ the Compoſition of the ſame individual Plants;’

From hence muſt be inferred, that the ſame Plant takes in very many and different Ingredients (and it is proved, that no Plant refuſes any Ingredient (*d*) that is capable of entering its Roots. Tho’ the terreſtrial Particles which nouriſh *Vegetables*, be not perfectly homogeneous; yet moſt of the various

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(*c*) In *Philoſ. Tranſ.* No. 253.

(*d*) Dr. *Grew*, in his Anatomy of Plants, by microſcopical Inſpection, found, that the outer Superficies of Roots was of a ſpongy Subſtance; and ’tis well known, that no ſuch Body can refuſe to imbibe whatever Liquor comes in Contact with it, but will by its ſpringy Poroſity abſorb any ſort of Moiſture.

Taſtes and Flavours of Plants are made in and by the Veſſels (*e*).

Doctor *Woodward* ſays, ‘ That Water will paſs ‘ Pores and Interſtices, that neither Air, nor any ‘ other Fluid, will: This enables it to enter the fineſt ‘ Tubes and Veſſels of Plants, and to introduce the ‘ terreſtrial Matter, conveying it to all Parts of them; ‘ whilſt each, by means of Organs ’tis endow’d with ‘ for the Purpoſe, intercepts, and aſſumes into itſelf, ‘ ſuch Particles as are ſuitable to its own Nature (*f*); ‘ letting the reſt paſs on *through the common Ducts*.’

Here then he ſays plainly, That each Plant receives the terreſtrial Matter in groſs, both ſuitable and unſuit-

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(*e*) We are convinced, that ’tis the Veſſels of Plants that make the different Flavours; becauſe there is none of theſe Flavours in the Earth of which they are made, until that has enter’d and been alter’d by the vegetable Veſſels.

(*f*) If the Doctor’s Plants were ſo nice in leaving vegetable Matter *behind, quiet and undiſturb’d*, ’tis a wonder they would take up the mineral Matter, as, he ſays, they did, that kill’d themſelves with Nitre.

Theſe Plants might, with much leſs Difficulty, have diſtinguiſh’d the mineral Matter from the vegetable Matter, than they could diſtinguiſh the different Particles of vegetable Matter from one another; and muſt have been very unwiſe to chuſe out the Nitre (their Poiſon) from the Water and Earth, and to leave the vegetable Particles behind; none of which could be ſo improper to them as the Nitre.

It may perhaps be objected, that ſuch-like pernicious Matter kills a Plant by only deſtroying its Roots, and by cloſing the Pores; which prevents the Nouriſhment from entering to maintain its Life; and that ſuch Matter doth not itſelf enter to act as Poiſon upon the Sap, or upon the Veſſels of the Body, or Leaves: But it plainly appears that it doth enter, and act as Poiſon; for when ſome of the Roots of a Mint, growing in Water, are put into ſalt Water, it kills the whole Plant, although the reſt of the Roots remaining in the freſh Water were ſufficient to maintain it, if the other Roots had been cut off at the time they were removed into the ſalt Water; and alſo all the Leaves, when dead, will be full of Salt.

Or if the Juice of wild Garlick-ſeed be made uſe of inſtead of the ſalt Water, it will have the ſame Effect; and every one of the Mint-leaves will have a ſtrong Taſte of Garlick in it.

unſuitable to its Nature, retains the ſuitable Particles for its Augment, and the unſuitable lets paſs through it. And in another Place he ſays they are exhal'd into the Atmoſphere.

And this will appear to be the true Caſe of Plants; and directly contradicts what he advances, in ſaying, 'That each Sort of Grain takes forth that peculiar 'Matter that is proper for its own Nouriſhment. 'Firſt, the Wheat draws off thoſe Particles that ſuit 'the Body of that Plant, *the reſt lying all quiet and 'undiſturb'd the while.* And when the Earth has 'yielded up all them, thoſe that are proper for Barley, a different Grain, remain ſtill behind, till the 'ſucceſſive Crops of that Corn fetch them forth too; 'and ſo the Oats and Peaſe in their turn, till, in fine, 'all is carried off.'

In the former Paragraph he ſays, each Plant *lets paſs through it* the reſt of the Particles that are not ſuitable to its own Nature. In the latter Paragraph he ſays, That each *leaves* the unſuitable *all behind* for another Sort; and ſo on.

Both cannot be true.

If the latter were true, Change of Sorts would be as neceſſary as it is commonly thought. But if the former be true, as I hope to prove it is, then there can be no Uſe of changing of Sorts in reſpect of different Nouriſhment.

If in this Series of Crops each Sort were ſo juſt as to take only ſuch Particles, as are peculiarly proper to it, letting all the reſt alone to the other Sorts to which they belonged, as the Doctor imagines; then it would be equal to them all, which of the Sorts were ſown firſt or laſt: But let the Wheat be ſown after the Barley, Peaſe, and Oats, inſtead of being ſown before them, and then it would evidently appear, by that ſtarv'd Crop of Wheat, either that ſome or all of thoſe other Grains had violated this natural Probity, or elſe that Nature has given to *Vegetables* no ſuch Law of *Meum* and *Tuum*(g).

If theſe Things were, as the Doctor affirms, why do Farmers loſe a Year's Rent, and be at the Charge of fallowing and manuring their Land, after ſo few Crops; ſince there are many more Sorts of Grain as different from theſe and one another, as thoſe are which they uſually ſow?

They ſtill find, that the firſt Crops are beſt; and the longer they continue ſowing, the worſe the laſt Crops will prove, be they of never ſo different a Species; unleſs the Land were not in ſo good Tilth for the firſt Crop as for the ſubſequent; or unleſs the laſt ſown be of a more robuſt Species.

This Matter might be eaſily clear'd, could we perfectly know the Nature of thoſe ſuppoſed *unſuitable* (h) *Particles*; but, in Truth, there is no more to be known of ſuch of them, than that they are carried away by the Atmoſphere to a Diſtance, according to the Velocity of the Air; perhaps ſeveral Miles off, at leaſt, never like to return to the Spot of Ground from whence the Plants have raiſed them.

(g) A Charlock could not rob a Turnep, and ſtarve it, more than ſeveral Turneps can do, unleſs the Charlock did take from it the ſame Particles which would nouriſh a Turnep; and unleſs the Charlock did devour a greater Quantity of that Nouriſhment than ſeveral Turneps could take.

Flax, Oats, and Poppy, could not burn or waſte the Soil, and make it leſs able to produce ſucceeding Crops of different Species; unleſs they did exhauſt the ſame Particles which would have nouriſh'd Plants of different Species: For let the Quantity of Particles theſe Burners take be never ſo great, the following Crops would not miſs them, or ſuffer any Damage by the Want or Loſs of them, were they not the ſame Particles which would have nouriſhed thoſe Crops, if the Burners had left them *behind, quiet and undiſturbed.* Neither could Weeds be of any Prejudice to Corn, if they did draw off thoſe Particles only that ſuit the Bodies of Weeds, *the reſt lying all quiet and undiſturbed the while.* But conſtant Experience ſhews, that all Sorts of Weeds, more or leſs, diminiſh the Crop of Corn.

(h) But we muſt not conclude, that theſe Particles, which paſs through a Plant (being a vaſtly greater Quantity than thoſe that abide in it for its Augment), are all unſuitable, becauſe no one of them happens to hit upon a fit *Nidus*: For ſince the Life of Animals depends upon that of Plants, 'tis not unreaſonable to imagine, that Nature may have provided a conſiderable Overplus

But ſuppoſe theſe caſt-off Particles were, when taken in, unfit for the Nouriſhment of any manner of Vegetables: Then the Doctor muſt fanſy the Wheat to be of a very ſcrupulous Conſcience, to feed on theſe Particles, which were neither fit for its own Nouriſhment, nor of any other Plant; and at the ſame time to forbear to take the Food of Barley, Peaſe, and Oats, letting that *lie ſtill and undiſturb'd the while*, as he ſays it does, tho' he gives no manner of Reaſon for it.

'Tis needleſs to bring ſtronger Arguments, than the Doctor's Experiments afford, againſt his own vulgar Opinion, of Plants diſtinguiſhing the particular Sort of terreſtrial Matter, that, he ſays, is proper to each Sort of *Vegetable*, in theſe Words; *viz.* 'Each Sort 'takes forth that peculiar Matter that is proper for its 'own Nouriſhment, the *reſt lying all quiet and undiſ*'*turb'd the while.*'

He ſays, that great Part of the terreſtrial Matter, mixed with the Water, paſſes up into the Plant along with it; which it could not do, if only the peculiar Matter, proper to each Plant, did paſs up into it: And after he has ſhewed how apt the vegetable Matter is to attend Water in all its Motions, and to follow it into each of its Receſſes; being by no Filtrations or Percolations wholly ſeparable from it; 'tis ſtrange he ſhould think that each Plant leaves the greateſt Part of it behind, ſeparated from the Water which the Plant imbibes.

plus for maintaining the Life of individual Plants, when ſhe has provided ſuch an innumerable Overplus for continuing every Species of Animals.

There are, doubtleſs, more than a Million of Sorts of Plants, all of which would have taken up the Water, and had each as much Right to its Share, or proper Matter in it, as the Doctor's Plants had; and then there would be but a very ſmall (or a Millionth) Part of it proper to each of his Plants: And theſe leaving all the reſt behind, both of the Water wherewith the Glaſſes at firſt were filled, when the Plants were put into them; and alſo of all the additional Water daily ſupply'd into them afterwards; I ſay, ſo much more terreſtrial Matter brought into theſe Glaſſes, in proportion to the added Water, and ſo very ſmall a Part as could be proper to each of his Plants being carried off; there muſt have remain'd in theſe Glaſſes a much greater Quantity of terreſtrial Matter at the End of the Experiment, than remained in the Glaſſes *F* or *G*, which had no Plants in them, nor any Water added to, or diminiſhed from them; but the quite contrary appear'd. ‘And the Water in ‘ the Glaſſes *F* and *G*, at the End of the Experiment, ‘ exhibited a larger Quantity of terreſtrial Matter, ‘ than any of thoſe that had Plants in them did. The ‘ Sediment at the Bottom of the Glaſſes was greater, ‘ and the *Nubeculæ* diffuſed thro' the Body of the ‘ Water thicker.’ Had the *Cataputia* inſum'd, with the Two thouſand Five hundred and One Grains of Water, no more than its proper Share of the vegetable Matter, it could not have attained thence an Increaſe of Three Grains and a Quarter, nor even the Thouſandth Part of One Grain. But he found ‘this ‘ terreſtrial Matter, contained in all Water, to be ‘ of Two Kinds: The one properly, a vegetable ‘ Matter, but conſiſting of very different Particles; ‘ ſome of which are proper for the Nouriſhment of ‘ ſome kind of Plants, others for different Sorts,’ *&c.*

This, indeed, would have been moſt wonderful Diſcovery; and might have given us a great Light, if he had told us in what Language and Character theſe proper Differences were ſtamp'd or written upon the vegetable Particles; which Particles themſelves, he ſays, were ſcarce viſible. Certainly it muſt be a great Art (much beyond that of Dr. *Wallis)* to decypher the Language of Plants, from inviſible Characters.

But that this Dream may deceive none, except ſuch who are very fond of old Errors, there is an *Experimentum Crucis* which may convince them; *viz.* At the proper Seaſon, tap a Birch-tree in the Body or Boughs, and you may have thence a large Quantity of clear Liquor, very little altered from Water; and you may ſee, that every other Species of Plants, that will grow in Water, will receive this; live and grow in it, as well as in common Water. You may make a like Experiment by tapping other Trees, or by Water diſtilled from Vegetables; and you will find no Species of Plants, into which this Water will not enter, and paſs through it, and nouriſh it too; unleſs it be ſuch a Species as requires more Heat than Water admits; or unleſs the peculiar Veſſels of that it has firſt paſſed through, have ſo altered the vegetable Particles contained in that Water, as that it acts as Poiſon upon ſome other particular Species.

The Doctor concludes, 'That Water is only the 'Agent that conveys the vegetable Matter to the 'Bodies of Plants, that introduces and diſtributes 'it to their ſeveral Parts for their Nouriſhment: 'That Matter is ſluggiſh and inactive, and would lie 'eternally confin'd to its Beds of Earth, without 'ever advancing up into Plants, did not Water, or 'ſome like Inſtrument, fetch it forth, and carry it 'unto them.'

That Water is very capable of the Office of a Carrier to Plants, I think the Doctor has made moſt evident; but as to the Office of ſuch an Agent as his Hypotheſis beſtows upon it, it ſeems impoſſible to be executed by Water. For it cannot be imagined, that Water, being itſelf but mere homogenial Matter, void of all Degrees of Life, ſhould diſtinguiſh each Particle of vegetable Matter, proper and peculiar to every different Species of Plants, which are innumerable; and when 'tis to act for the Wheat, to find out all the Particles proper to that ſort of Grain, to rouſe only thoſe particular Sluggards from their Beds of Earth, letting all the reſt lie quiet and undiſturbed the while. This Agent frees the Wheat-particles from their Confinement, and conveys, introduces, and diſtributes them, and only them, into the ſeveral Parts of the Wheat.

Since 'tis unreaſonable to believe, that Water can have ſuch extraordinary Skill in Botany, or in Micrography, as to be qualified for a ſufficient Agent in ſuch an abſtruſe Matter, I conceive Water to be only an Inſtrument or Vehicle, which takes up indifferently any Particles it meets with (and is able to carry), and advances them (or the *Pabulum* they yield) up into the Firſt Plant, whoſe Root it comes in Contact with; and that every Plant it meets with, does accept thereof, without diſtinguiſhing any different Sorts or Properties in them, until they be ſo far introduc'd and advanc'd up into the vegetable Veſſels, that it would be in vain to diſtinguiſh them; for whether the terreſtrial Matter, Plants imbibe with the Water, will kill or nouriſh them, appears by its Effects; but which cannot be foreknown or prevented without the Help of Faculties, which Plants are not endow'd with.

Mr. *Bradley* ſeems to have carried this Error farther than any Author ever did before; but he ſupports it by Affirmations only, or by ſuch Arguments (I cannot ſay Reaſons; for no Reaſon can be againſt any Truth) as go near to confute the very Opinion he pretends to advance by them.

He aſcribes to Vegetables the Senſe of Taſte, by which he thinks they take ſuch Nouriſhment as is moſt agreeable to their reſpective Natures, refuſing the reſt; and will rather ſtarve, than eat what is diſagreeable to their Palate.

In the Preface to his *Vol.* I. *Page* 10. of his *Huſbandry* and *Gardening*, he ſays, 'They feed as differently as Horſes do from Dogs, or Dogs from 'Fiſh.'

But what does he mean by this Inſtance, *Vol.* I. *p.* 39. *viz.* 'That Thyme, and other Aromatics, being planted 'near an Apricot-tree, would deſtroy that Tree?' Does it not help to confirm, that every Plant does not draw exactly the ſame Share of Nouriſhment?

I believe there is no need for him to give more Inſtances to diſprove his Aſſertion than this one. His Concluſion, taken by itſelf, is ſo far right; *viz.* 'That if the Nouriſhment the Earth afforded to the 'Thyme and Apricot-tree, had been divided into 'Two Shares, both could not have had them.'

But this his Inſtance proves, That thoſe Aromatics robb'd the Apricot-tree of ſo much of its Share as to ſtarve it; and that they, tho' of ſo very different a Nature, did draw from the Earth the ſame Nouriſhment which the Apricot-tree ſhould have taken for its Support, had not the Aromatics been too hard for it, in drawing it off for their own Maintenance:

Unleſs he believes, that all the Juices of the Aromatics were as Poiſon to the Apricot; and that, according to my Experiment of the Mint, ſome of their Roots might diſcharge ſome kind of Moiſture in dry Weather, given them by others, that had it for their Uſe; and that the Apricot-roots, mingling with them, might imbibe enough of that Liquor, altered ſufficiently by their Veſſels, to poiſon and kill the Tree.

But then, where was the Tree's diſtinguiſhing Palate? Why did it not refuſe this Juice, which was ſo diſagreeable as to kill it? And as to his Notion of

Vegetables having Palates, let us ſee how it agrees with what he affirms.

‘ That ’tis the Veſſels of Plants that make, by ‘ their Filtrations, Percolations, *&c.* all the different ‘ Taſtes and Flavours of the Matter, which is the ‘ Aliment of Plants; and that, before it be by them ‘ ſo filtred, *&c.* it is only a Fund of inſipid Subſtance, ‘ capable of being altered by ſuch Veſſels, into any ‘ Form, Colour, or Flavour.’

And *Vol.* I. *p.* 38. ‘ The different Strainers, or ‘ Veſſels of the ſeveral Plants, growing upon that ‘ Spot of Earth, thus impregnated with Salts, alter ‘ thoſe Salts or Juices, according to the ſeveral Fi‘ gures or Dimenſions of their Strainers; ſo that ‘ one Plant varies, in Taſte and Smell, from others, ‘ tho’ all draw their Nouriſhment from the ſame ‘ Stock lodged in the Earth.’ See Mr. *Bradley*’s *Palates of Plants*, and the inſipid Subſtance he allots them to diſtinguiſh the Taſte of, how they agree.

They muſt, it ſeems, within their own Bodies, give the Flavour to this inſipid Subſtance, before their Palates can be of any Uſe; and, even then, ’tis impoſſible to be of any Uſe, but in the manner of the Dog returning to his Vomit.

They would have as much occaſion for the Senſe of Smelling, as of Taſte; but, after all, of what Uſe could either of the Two be to Plants, without local Motion of their Roots? which they are ſo deſtitute of, that no Mouth of a Root can ever remove itſelf from the very Point where it was firſt formed, becauſe a Root has all its longitudinal Increaſe at the very End; for, ſhould the Spaces betwixt the Branchings increaſe in Length, thoſe Branches would be broken off, and left behind, or elſe drawn out of their Cavities; which muſt deſtroy the Plant. All the Branches, except the foremoſt, would be found with their Extremities pointing towards the Stem; the contrary of which Poſture they are ſeen to have: And if they moved backwards, that would have much the ſame Effect on all the collateral Branchings to deſtroy them. Smell and Taſte then could be of no manner of Uſe to Vegetables, if they had them; they would have no Remedy or Poſſibility to mend themſelves from the ſame Mouths, removing to ſearch out other Food, in caſe they had Power to diſlike or refuſe what was offered them.

Therefore the crude Earth, being their Food, ſimple and free from any Alterations by Veſſels, remaining inſipid, cannot give, neither can Plants receive, require, or make uſe of, any Variety from it, as Animals do from their Diet. It would be loſt upon them, and Nature would have acted in vain, to give Smell and Taſte to Vegetables, and nothing but inſipid Earth for an Object of them; or to give them a charming Variety of Reliſh and Savour in their Food, without giving them Senſes neceſſary to perceive or enjoy them; which would be like Light and Colours to the Blind, Sound and Muſic to the Deaf; or like giving Eyes and Ears to Animals, without Light or Sound to affect them.

The Mouths of Plants, ſituate in the convex Superficies of Roots, are analogous to the Lacteals, or Mouths, in the concave Superficies of the Inteſtines of Animals.

Theſe ſpongy Superficies of animal Guts, and vegetable Roots, have no more Taſte or Power of refuſing whatever comes in Contact with them, the one than the other.

The free open Air would be equally injurious to both; and if expoſed to it, it would dry and cloſe up the fine Orifices in Guts and Roots: Therefore Nature has guarded both from it.

Nature has alſo provided for the Preſervation of both Vegetables and Animals (I do not ſay equally) in reſpect of their Food; which might poiſon them, or might not be fit to nouriſh them.

The Security of Plants (the beſt that can be) is their Food itſelf, Earth; which, having been altered by no Veſſels, is always ſafe and nouriſhing to them: For a Plant is never known to be poiſoned by its own natural Soil, nor ſtarved, if it were enough of it, with the requiſite Quantities of Heat and Moiſture.

Roots, being therefore the Guts of Plants, have no need to be guarded by Senſes; and all the Parts and Paſſages, which ſerve to diſtinguiſh and prepare the Food of Animals, before it reach the Guts, are omitted in Plants, and not at all neceſſary to them.

But as the Food of moſt Animals is Earth, very variouſly changed and modified by vegetable or animal Veſſels, or by both, and ſome of it is made wholſome, ſome poiſonous; ſo that if this doubtful Food ſhould be committed to the Inteſtines, without Examination, as the pure unaltered Earth is to Roots, there would, in all Probability, be very few Animals living in the World, except there be any that feed on Earth at firſt Hand only, as Plants do:

Therefore, leſt this Food, ſo much more refined than that of Plants, ſhould, by that very means, become a fatal Curſe, inſtead of a Bleſſing, to Animals; Nature has endowed them with Smell and Taſte, as Sentinels, without whoſe Scrutiny theſe various uncertain Ingredients are not admitted to come where they can enter the Lacteals, and to diſtinguiſh, at a ſufficient Diſtance, what is wholſome and friendly, from what is hurtful; for when 'tis once paſſed out of the Stomach into the Guts, 'tis too late to have Benefit from Emetics; its Venom muſt then be imbibed by the Lacteal Mouths, and mix with the Blood, as that muſt mix with the Sap, which comes in Contact with the Lacteals in the Superficies of Roots, Nature having left this unguarded.

Yet Plants ſeem to be better ſecured by the Salubrity and Simplicity of their Food, than Animals are by their Senſes: To compenſate that Inequality of Danger; Animals have Pleaſure from their Senſes, except ſome miſerable Animals (and ſuch there are) that have more Pain than Pleaſure from them. But I ſuppoſe, more Animals than Plants are poiſon'd; and that a poiſonous Animal is leſs fatal to a Plant, than a poiſonous Plant is to an Animal.

It being ſufficiently proved, that every ſort of Vegetables, growing in the ſame Soil, takes, and is nouriſhed, by the ſame Sort of Food; it follows from hence, that the beneficial Change of Sorts of Seeds or Plants, we ſee in the common Huſbandry, is not from the Quality of the Sorts of Food, but from other Cauſes; ſuch as,

I. *Quantity of the Food.*
II. *Conſtitution of the Plants.*
III. *Quantity of the Tillage.*

In Dr. *Woodward*'s Caſe, upon his Hypotheſis, the Three Proportions of Seeds, *viz.* Barley, Oats, and Peaſe, might be ſown all together in the ſame Acre of Ground, the ſame Year, and make Three as good Crops as if ſown ſingly in Three ſucceſſive Years, and his Two Crops of Wheat in One Year likewiſe. But every Farmer can tell, that theſe Three Proportions of Seed would not yield half the Crop together, as one would do ſingle; and would ſcarce produce more than to ſhew what Grains were ſown, and which of the Sorts were the ſtrongeſt, and the moſt able Robber.

Though this Failure would, in Truth, be from no other Cauſe than want of the ſufficient Quantity of Food, which thoſe Three Crops required; yet, perhaps, the Doctor might think, that all Three Crops might ſucceed together very well, taking each its proper Nouriſhment, were it not for want of Room, Air, and Sun.

I have been credibly inform'd, that on One Perch of Ground there has grown a Buſhel of Corn, which is Twenty Quarters to an Acre. Mr. *Houghton* relates Twenty-ſix, and even Thirty Quarters, of Wheat on One Acre. There have certainly grown Twelve Quarters of Barley to an Acre, throughout a whole Field: Therefore, unleſs a Crop exceed the leaſt of theſe, or indeed the greateſt of them (if the Relation be true), a Crop cannot fail for want of Room; for one Acre (be it of what Nature it will, as to the Soil of it) muſt have as much room for a Crop to grow on, as any other Acre.

Then there was room for all Dr. *Woodward*'s Three Crops together, to produce as much as Three common Crops do. Yet all theſe together will ſcarce yield one Quarter of Corn, tho' there is room, at leaſt, for Twelve.

The ſame *Air* and *Sun* that had Room to do their Office to Mr. *Houghton*'s Acre, why ſhould they not have Room to do the ſame to Doctor *Woodward*'s Acre, when the Three Crops growing on it at once, through pretty good ones, might require leſs Room than Mr. *Houghton*'s Crop did?

I perceive that thoſe Authors, who explain *Vegetation*, by ſaying the Earth imbibes certain Qualities from the Air, and by ſpecific Qualities, and the like, do alſo lay a great Streſs upon the *perpendicular* Growth of *Vegetables*; ſeeming to fanſy there is little elſe neceſſary to a good Crop, but Room.

Mr. *Bradley*, in his Arguments concerning the Value of an Hill, does implicitly ſay as much.

But if they would but conſider the Diameters of the Stems, with the Meaſure of the Surface of an Acre, they would be convinced, that many, even of Mr. *Houghton*'s Crops, might ſtand in a perpendicular Poſture upon an Acre, and Room be left.

One true Cauſe of a Crop's failing, is want of a Quantity of Food to maintain the Quantity of Vegetables, which the Food ſhould nouriſh.

When the Quantity of Food which is ſufficient for another Species (that requires leſs), but not for that which laſt grew, to grow again the next Year, then that other is beneficial to be planted after it.

The Second true Cauſe is from the Conſtitution of Plants; ſome require more Food than others, and ſome are of a ſtronger Make, and better able to penetrate the Earth, and forage for themſelves.

Therefore Oats may ſucceed a Crop of Wheat on ſtrong Land, with once plowing, when Barley will not; becauſe Barley is not ſo well able to penetrate as Oats, or Beans, or Peaſe, are.

So a Pear-tree may ſucceed a Plum-tree, when another Plum-tree cannot; becauſe a Pear is a much ſtronger Tree, and grows to a much greater Bulk; ſo inclined to be a Giant, that 'tis hard to make it a Dwarf; and will penetrate and force its Way thro' the untill'd Earth, where the other cannot; being of a weaker and leſs robuſt Conſtitution, not ſo well able to ſhift for itſelf.

The Pear could penetrate Pores that the other could not. Mr. *Evelyn* ſays, in his Diſcourſe of Foreſt-trees, 'That a Pear will ſtrike Root thro' the 'rougheſt and moſt impenetrable Rocks and Clifts 'of Stone itſelf.' He ſays likewiſe, in his *Pomona*, 'That Pears will thrive where neither Apple or other 'Fruit could in Appearance be expected.'

I can ſcarce think, that a large Plant takes in larger Particles than a ſmall one, for its Nouriſhment: If it did, I can't believe, that the Thyme could have ſtarv'd the Apricot-tree; it muſt have left the larger Particles of Food for that Tree, which probably would have ſufficed to keep it alive: I rather think, that great and ſmall Plants are ſuſtain'd by the ſame minute Particles; for, as the fine Particles of Oats will nouriſh an Ox, ſo they will nouriſh a Tom-tit, or a Mite.

Some Plants are of an hotter Conſtitution, and have a quicker Digeſtion, like Cormorants or Pigeons, devouring more greedily, and a greater Quantity of Food, than thoſe of a colder Temperature, of equal Bulk, whoſe Sap, having a more languid Motion, in proportion to the leſs Degree of Heat in it, ſends off fewer Recrements; and therefore a leſs Supply of Food is required in their room. This may make ſome Difference in the one's ſucceeding the other; becauſe the hot-conſtitution'd leaves not enough for its own Species to ſucceed again, but leaves enough for a Species of a colder Conſtitution to ſucceed it.

But the Third and chiefeſt Cauſe of the Benefit of changing Sorts is Quantity of Tillage, in proportion to which the Food will be produced.

The true Cauſe why Wheat is not (eſpecially on any ſtrong Soil) to be ſown immediately after Wheat, is, That the firſt Wheat ſtanding almoſt a Year on the Ground, by which it muſt grow harder; and Wheat Seed-time being ſoon after Harveſt in *England*; there is not Space of time to till the Land ſo much as a ſecond Crop of Wheat requires.

Tho' ſometimes in poorer Land, that is lighter, Wheat has ſucceeded Wheat with tolerable Succeſs; when I have ſeen, on very rich ſtrong Land, the firſt Crop loſt by being much too big, and one following it immediately, quite loſt by the Poorneſs of it, and not worth cutting.

This was enough to ſatisfy, that the Tillage which was ſo much eaſier perform'd in leſs time, ſufficed for the light Land, but not for the ſtrong; and, if the ſtrong Land could have been brought into as good Tilth as the light (like as in the new Huſbandry it may), it would have produced a much better ſecond Crop than the light Land did.

From all that has been ſaid, theſe may be laid down as Maxims; *viz.* That the ſame Quantity of

Tillage will produce the ſame Quantity of Food in the ſame Land *(a)*; and that the ſame Quantity of Food will maintain the ſame Quantity of Vegetables.

'Tis ſeen, that the ſame Sort of Weeds, which once come naturally in a Soil, if ſuffer'd to grow, will always proſper in proportion to the Tillage and Manure beſtow'd upon it, without any Change. And ſo are all manner of Plants, that have been yet try'd by the new Husbandry, ſeen to do.

A Vineyard, if not tilled, will ſoon decay, even in rich Ground, as may be ſeen in thoſe in *France*, lying intermingled as our Lands do in common Fields. Thoſe Lands of Vines, which by reaſon of ſome Law-ſuit depending about the Property of them, or otherwiſe, lie a Year or two untilled, produce no Grapes, ſend out no Shoots hardly; the Leaves look yellow, and ſeem dead, in Compariſon of thoſe on each ſide of them; which, being tilled, are full of Fruit, ſend out an hundred times more Wood, and their Leaves are large and flouriſhing; and continue to do the ſame annually for Ages, if the Plough or Hoe do not neglect them.

No Change of Sorts is needful in them, if the ſame annual Quantity of Tillage (which appears to provide the ſame annual Quantity of Food) be continued to the Vines.

But what in the Vineyards proves this Theſis moſt fully is, That where they conſtantly till the low Vines

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(a) Add *cæteris paribus*; for when the Land has been more exhauſted, more Tillage (or Dung) or Reſt will be required to produce the ſame Quantity of Food, than when the Land hath been leſs exhauſted. By Tillage is here meant, not only the Number of Plowings, but the Degree of Diviſion or Pulveration of the Soil; or, if perchance the Soil is extraordinary much exhauſted by many Crops, without proper Tillage between them, the greater Degree of Pulveration, by Plowing or Dung (which is only a *Succedaneum* of Tillage), and alſo a longer Time of expoſure, may be neceſſary to counterpoiſe that extraordinary Exhauſtion.

with the Plough, which is almoſt the ſame with the Hoe plough, the Stems are planted about Four Feet aſunder, chequerwiſe; ſo that they plow them Four ways. When any of theſe Plants happen to die, new ones are immediately planted in their room, and exactly in the Points or Angles where the other have rotted; elſe, if planted out of thoſe Angles, they would ſtand in the Way of the Plough: Theſe young Vines, I ſay, ſo planted in the very Graves, as it were, of their Predeceſſors, grow, thrive, and proſper well, the Soil being thus conſtantly tilled: And if a Plum-tree, or any other Plant, had ſuch Tillage, it might as well ſucceed one of its own Species, as thoſe Vines do.

'Tis obſerved, that White-thorns will not proſper, ſet in the Gaps of a White thorn Hedge: But I have ſeen the Banks of ſuch Gaps dug and thrown down one Summer, and made up again, and White-thorns there replanted the following Winter, with good Succeſs.

But note, That the annual plowing the Vines is more beneficial than the one Summer Tillage of the Banks, the Vines having it repeated to them yearly.

I have, by Experience and Obſervation, found it to be a Rule, That long Tap-rooted Plants, as Clover, and St Foin, will not ſucceed immediately after thoſe of their own or any other Species of long Tap-roots, ſo well as after horizontal-rooted Plants; but, on the contrary, horizontal will ſucceed thoſe Tap-roots as well or better than they will ſucceed horizontal.

I confeſs, this Obſervation did, for a great while, cheat me into the common Belief, That different Species of Plants feed on different Food; till I was delivered from that Error, by taking notice, that thoſe Tap-roots would thrive exceedingly well after Tnrneps, which have alſo pretty long Tap-roots, though Turneps never thrive well immediately after

Clover *(a)*, or St. Foin: I found the true Cauſe of this Exception to that Rule to be chiefly the different Tillage (*b*).

Land muſt be well tilled for Turneps, which alſo are commonly ho'd; they ſtand ſcarce ever above Three-quarters of a Year, and are then fed on the Ground; and then the ſucceeding Crop of Corn has, by that means, the Benefit of twice as much Tillage from the Hoe, as otherwiſe would be given to it; and the Broad Clover, or St. Foin, ſown with the Corn (if the Corn be not ſo big as to kill it), will enjoy, in its Turn, a Proportion of the extraordinary Tillage, and of the Dung of Cattle, which feed the Turneps, and thrive accordingly: But Broad Clover and St. Foin, being perennial Plants, ſtand on the Ground ſo long, that it lies ſeveral Years untill'd; ſo that Turneps, ſown immediately after theſe, do fail, for want of their due Tillage, for which there is not ſufficient time, by plowing often enough; becauſe, by the common Ploughs, it requires Two or Three Years to make it fine enough for Turneps, or for a Repetition of Clover, or St. Foin, in ſtrong or ſwerdy Land.

Another Reaſon why any Crop ſucceeds well after Turneps (and beſides their being ſpent on the Ground where they grow) is their cold Conſtitution, by which they are maintained with leſs Food, than another Plant of the ſame Bulk.

The *Parenchyma*, or fleſhy Part of a Turnep, conſiſting of a watry Subſtance, which cools the Veſſels, whereby the Sap's Motion is very ſlow, in proportion to the very low Degree of Heat it has, and

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(*a*) But when Clover has been fed by Cattle, the Ground being good, and well tilled, Turneps may thrive immediately after Clover: Therefore this is an Exception to the general Rule.

(*b*) Very mellow rich Land is ſo full of vegetable Food, that 'tis an Exception to moſt Rules; and therefore I ſpeak not of that.

ſends off its Recrements in the ſame Proportion likewiſe; and therefore requires the leſs of the terrene Nouriſhment to ſupply thoſe Recrements.

This is ſeen, when a Buſhel of Turneps, mix'd with a Quantity of Wheaten Flour, is made into Bread, and well baked: This Buſhel of Turneps gives but few Ounces Increaſe in Weight, more than the ſame Quantity of Wheaten Flour made into Bread, and baked without any Turneps. This ſhews there is in a Turnep very little Earth (which is the moſt permanent Subſtance of a Plant); the Oven diſcharges in Vapour, near all but the largeſt Veſſels: Its earthy Subſtance being ſo ſmall, is a Proof 'tis maintained by a ſmall Quantity of Earth; and, upon that Account alſo, of leſs Damage to the next Crop, than another Plant would be, which required more of the ſolid Nouriſhment to conſtitute its firmer Body, as a Charlock does; for when a Charlock comes up, contiguous to, and at the ſame time with a Turnep, it does ſo rob the Turnep, that it attains not to be of the Weight of Five Ounces; when a ſingle Turnep, having no more Scope of Ground, and, in all reſpects (but the Vicinity of the Charlock), equal, weighs Five Pounds, yet that Charlock does not weigh One Pound.

And where Three Turneps coming up, and growing thus contiguous, will weigh Four Pounds; a Charlock joined with Two or Three Turneps, all together, will be leſs than one Pound, upon no leſs Space of Ground.

This Obſervation cannot be made, except where Turneps are drill'd in Rows; and there 'tis eaſy to demonſtrate, that a Charlock, during the time of its ſhort Life, draws much more Earth than a Turnep of equal Bulk, from an equal Quantity of Ground (*c*).

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(*c*) 'Tis certain that Turneps, when they ſtand for Seed, ſuck and impoveriſh the Ground exceedingly: For though they are of a

The true Cauſe why Clover, and St. Foin, do not ſucceed ſo well after their own reſpective Species, or that of each other, as Corn, *&c.* can, is, that they take great Part of their Nouriſhment from below the Plough's Reach, ſo as that under Earth cannot be tilled deep enough, but the upper Part may be tilled deep enough for the horizontal Roots of Corn, *&c.* towards which, the Rotting of the Clover and St. Foin Roots, when cut off by the Plough, do not a little contribute *(d)*: And there's no doubt but that, if the

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a cold Conſtitution, and conſequently conſume leſs Food than Plants of an hotter Conſtitution, and of the ſame Bulk; yet theſe Seed-turneps being of ſo vaſt a Bulk, as ſometimes Eighty Quarters of their Roots grow on an Acre, and their Stalks have been meaſured Seven Feet high; and their Roots having continued at near their full Bigneſs for about Ten Months together, and then carried off; they drain the Land more than a Crop of other Vegetables of leſs Bulk, and an hotter Conſtitution, and which live a leſs time; or than Wheat, which, though it lives as long, is very ſmall, except in the Four laſt Months.

(d) That the Rotting of vegetable Roots in the Ground doth ferment therein, and improve it for horizontal-rooted Plants, I am convinced by an Accident; *viz.* My Man had plowed off the Earth cloſe to the Rows in a Field of extraordinary large Turneps deſign'd for Seed. This Earth was neglected to be thrown back to the Rows, until a ſevere Froſt in the Winter came, and killed the Turneps; upon which, in the Spring, the Field was ſown with Barley upon the Level, with only *once* plowing, and that croſs-ways of the Rows. The Turneps had ſtood ſo wide aſunder, that the Spot whereon each had rotted, appeared like the Spot whereon an Horſe had urined in tilled Ground, and was of a deeper Colour, and much higher, than the Barley that grew round thoſe Spots; and yet none of it was poor. As the Roots of Clover, and St. Foin, are very much leſs; yet the greater Number rotting in plow'd Ground muſt be of great Uſe to a following Crop of Corn.

I will here relate Two Examples of this in St. Foin: The one is, That a Field of Twenty-five Acres drilled with St. Foin, except Three Acres in the Middle of it, which was, at the ſame time, ſown with Hop-Clover; after Eight Years the whole Field was plowed up by a Tenant, and ſown with Corn: The St. Foin had been mowed yearly, as the Hop-Clover was not mowed at all, but fed the under Earth could be as well tilled for the Tap-roots, as the upper Earth is for the horizontal, the Tap-roots would ſucceed one another as well as the horizontal would ſucceed them, or thoſe of their own Species, or as the Tap-roots do the horizontal.

fed by Horſes tedder'd (or ſtaked) thereon the Firſt and Second Years; and after that had nothing on it but poor natural Graſs.

The whole Field was managed alike, when plowed up; but the Three Acres produced viſibly worſe Crops of Corn than the reſt all round it, which had produced St. Foin.

The other Example or Inſtance was, Where an Acre, Part of a Field, was, by a Fancy, drilled with St. Foin in ſingle Rows, about Thirty-three Inches aſunder, but was never hoed: After Seven Years it was plowed up with the reſt of the Field croſs the Rows, and ſown with Oats upon the Back Three Months after plowing. Theſe Rows were as viſible in the Oats, as if the St. Foin had been ſtill remaining there: The Oats in the Rows where the St. Foin had been, looked of a deep-green flouriſhing Colour, at firſt coming up, and until they were about half a Foot high, and the Spaces between them looked yellowiſh; but afterwards the Difference of their Colour diſappeared, all the Crop being very good. Upon this I imputed it to the Rotting of the Roots, which by their Singleneſs were very large; and when the different Colours diſappeared, I ſuppoſe the Roots of all the Oats had reached to the Benefit of the rotted Roots, which might alſo be then ſpread farther into the Spaces; and I doubt not but that the Rotting of Broad Clover-roots has the ſame Effect as of St. Foin, for manuring of Land, eſpecially when the Roots are large.

Some have objected againſt this Opinion, and ſay the Effect was rather to be imputed to the Rows of St. Foin ſhadowing the Earth under them, or elſe from their keeping the Earth under them free from Couch-graſs, of which the Intervals were full: But I think it more probable, that the Couch-graſs, having very long horizontal Roots, might draw Nouriſhment from the Earth under the Rows, and from the Intervals equally.

And as to the Shadow of the Rows, tho', for the Firſt and Second Years, the St. Foin Plants were very large; yet, being afterwards, for Five or Six Years, until plowed up, conſtantly fed by Cattle, and being more ſweet, was eaten very low, whilſt the Couch-graſs remained intire in the Intervals, and ſhadowed them more than the Earth of the Rows was ſhadowed by the St. Foin: Beſides, the rotten Turneps, which were free from both theſe Objections, had the ſame Effect on the Barley, as the St. Foin had on the Oats.

The under Earth, in ſome time, is repleniſh'd by what the Rains leave, when they ſink through it; and then Tap-rooted Plants may be there nouriſhed again, tho' the upper Earth be drained by the Corn; ſo that no Change is ſo beneficial, as that betwixt Tap-rooted Plants, and thoſe which have only horizontal ones. The former are provided for by Rains, tho' not ſo ſpeedily as the latter are by Tillage and Hoeing.

Paſtures require no Change of Herbs; becauſe they have annually the ſame Supply of Food from the Dunging of Cattle that feed on them, and from the Benefit of the Atmoſphere.

Meadows hold out without Change of Species of Graſs, tho' a Crop be carried off every Year; the Richneſs of that Soil, with the Help of the Atmoſphere, Dung of Cattle in feeding the After-Crop, or elſe Flooding, from the overflowing of ſome River, ſome, or all of which, ſupply the Place of the Plough to a Meadow.

Woods alſo hold out beyond Memory or Tradition, without changing Sorts of Trees; and this by the Leaves, and perhaps old Wood, rotting on the Soil annually, which operate as a Manure; becauſe, as has been ſaid, Earth which has once paſſed any Veſſels, is ſo changed, that, for a long time after, it does not retain its Homogeneity (*e*) ſo much as to mix with pure Earth, without fermenting; and by the Deſcent of the Atmoſphere, the Trees ſhadowing the Soil, to prevent the Reaſcent of what that brings down; all this, reſembling Tillage, continually divides the Soil, and renews the Food equal to the Conſumption of it made by the Wood.

And the laſt Argument I ſhall attempt to bring for Confirmation of all I have advanc'd, is that

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(*e*) Not that the Particles of Earth are ſtrictly homogeneous, but that they are much leſs heterogeneous, before they are altered by Veſſels, than afterwards.

which proves both the Truth and Uſe of the reſt; *viz.* That when any ſort of Vegetable, by the due Degrees of Heat and Moiſture it requires, is agreeable to a Soil, it may, by the new Horſe-hoeing Huſbandry, be continued without ever changing the Species.

CHAP. XV.

Of Change of INDIVIDUALS.

SEEDS, in their natural Climate, do not degenerate, unleſs Culture has improved them; and then, upon Omiſſion of that Culture, they return to their firſt natural State.

As the Benefit of changing of Species of Seeds is from Difference of Tillage, ſo the Benefit of changing Individuals of the ſame Species appears to be from thoſe Cauſes which are, generally, themſelves, the Effects of different Climates, ſuch as Heat and Moiſture, which may alſo vary very much in the ſame Latitude and Neighbourhood; as the ſame Mountain, in the Country of the *Mogul* (related by Mr. *Evelyn*, from Monſieur *Bernier*), on the South Side produces *Indian* Plants, and on the North Side *European* Plants, from different Expoſures; and ſome Land, retaining Water longer, is colder; ſome, ſuffering it to paſs down quicker, and by the Nature and Figure of its Parts, cauſes ſuch a Refraction and Reflexion of the Sun's Rays, which give a great Warmth, as in Sand, and gravelly Grounds, that are well ſituate, and have an under Stratum of ſome Sort of hollow Matter, next under the Staple (*a*),

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(*a*) This hollow Matter lets the Water paſs down the ſooner from the Surface, whereby the Staple of the Ground becomes the drier, and conſequently warmer.

or upper Stratum, wherein the Plough is exerciſed.

This beneficial Change of Individuals ſeems rather to be from the forementioned Cauſes, than from Change of Food; and theſe Cauſes ſhew their Efficacy, chiefly in the Generation or Fœtation of thoſe Seeds; as Flax-ſeed brought from *Holland*, and ſown here, will bring as fine Flax as there; but the very next Generation of it coarſer, and ſo degenerating gradually, after Two or Three Deſcents, becomes no better than the common ordinary Sort; yet its Food is the ſame, when the Flax is fine, as when 'tis coarſe.

And ſo it is, when Individuals of Wheat are changed: So Silkworms, hatch'd and bred in *France*, of Eggs or Seed brought from *Italy*, will make as fine Silk as the *Italian*; but the Eggs of theſe laid in *France*, and their Iſſue, will make no better Silk than the *French*; though their Food be from Leaves of the ſame Mulberry-trees, when they make fine Silk and coarſe: Therefore 'tis from the Climate, where the Eggs are impregnated, not where they have their Incubation or Food when hatch'd, and fed to their Lives End, that this Difference happens.

Common Barley, ſown once in the burning Sand, at *Patney* in *Wiltſhire*, will, for many Years after, if ſown on indifferent warm Ground, be ripe Two or Three Weeks ſooner than any other (*b*), which has never

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(*b*) Barley is far from being improved by becoming rath-ripe; for it loſes more good Qualities than it gets by being ſown at *Patney*: 'Tis ſo tender, that if it be ſown early, the Froſt is apt to kill it; or if it be ſown late in *May*, on the ſame Day, and in the ſame Soil, with the ſame Sort of Barley that is not rath-ripe, it will be much thinner bodied than the late-ripe; and beſides, if it happens to have any Check by Cold or Drought, it never recovers it as the other doth, at what time ſoever it is ſown. It is now, I am informed, gone out of Faſhion, and very few Farmers have ſown it of late Years. I know a little Pariſh, that, never been impregnate at *Patney:* But if ſown a Degree farther North, on cold clayey Land, will, in Two or Three Years, loſe this Quality, and become as late-ripe as any other.

Indeed *Patney* is far from improving the Species of Barley, except we think it improved by becoming more weak and tender, and ſhorter-lived; which laſt-mentioned Quality fits it for ſuch Countries, where the Summers are too ſhort for other Barley to ripen.

The Grains or Seeds of Vegetables are their Eggs; and the individual Plants, immediately proceeding from them, have not only the Virtues they received in Embryo (or rather *in plantulis)*, but the Diſeaſes alſo; for when ſmutty Wheat is ſown, unleſs the Year prove very favourable, the Crop will be ſmutty; which is an evident Token of *mala ſtamina.*

The ſmutty Grains will not grow; for they turn to a black Powder: But when ſome of theſe are in a Crop, then, to be ſure, many of the reſt are infected; and the Diſeaſe will ſhew itſelf in the next Generation, or Deſcent of it, if the Year wherein 'tis planted, prove a wet one.

Weeds, and their Seed, in the Fields where they grow naturally, for Time immemorial, come to as great Perfection as ever, without Change of Soil.

Theſe Weeds, with Acorns, and other Maſts, Crabs, Sloes, Hips, and Haws, are thought to have been, originally, the only natural Product of our Climate: Therefore other Plants being Exotics, many of them, as to their Individuals, require Culture and Change of Soil, without which they are liable, more or leſs, to degenerate.

But to ſay, that the Soil can cauſe Wheat to degenerate into Rye, or convert Rye into Wheat, is what

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I believe, formerly loſt about Two hundred Pounds *per Ann.* by ſowing rath-ripe Barley: But long and dear Experience hath now convinced them of their Error, and obliged them totally to diſuſe it.

reflects upon the Credit of *Laurembergius*: 'Tis as eaſy to believe, that an Horſe, by feeding in a certain Paſture, will degenerate into a Bull, and in other Paſture revert to an Horſe again; theſe are ſcarce of more different Species than Wheat and Rye are: If the different Soil of *Wittemberg* and *Thuringia* change one Species, they may the other.

CHAP. XVI.

Of RIDGES.

THE Method of plowing Land up into Ridges is a particular Sort of Tillage; the chief Uſe of which is, the Alteration it makes in the Degrees of Heat and Moiſture, being two of the grand Requiſites of Vegetation; for very different Degrees of theſe are neceſſary to different Species of Vegetables.

Thoſe Vegetables commonly ſown in our Fields, require a middle Degree of both, not being able to live on the Sides of perpendicular Walls in hot Countries, nor under Water in cold ones, neither are they amphibious, but muſt have a Surface of Earth not cover'd, nor much ſoak'd with Water, which deprives them of their neceſſary Degree of Heat, and cauſes them to languiſh. The Symptoms of their Diſeaſe are a pale or yellow Colour in their Leaves, and a Ceſſation of Growth, and Death enſues as ſure as from a Dropſy.

The only Remedy to prevent this Diſeaſe in Plants is, to lay ſuch wet Land up into Ridges, that the Water may run off into the Furrows, and be convey'd by Ditches or Drains into ſome River.

The more a Soil is fill'd with Water, the leſs Heat it will have.

The Two Sorts of Land moſt liable to be overglutted with Water, are Hills, whereof the *Upper Stratum* (or Staple) is Mould lying upon a *Second Stratum* of Clay.

And generally all ſtrong deep Land.

Hills are made wet and ſpewy by the Rain-water which falls thereon, and ſoaks into them as into other Land; but being ſtopp'd by the Clay lying next the Surface or Staple, cannot enter the Clay; and for want of Entrance, ſpreads itſelf upon it; and as Water naturally tends downwards, it is by the incumbent Mould partly ſtopp'd in its Deſcent from the upper towards the lower Side of an Hill; and being follow'd and preſs'd on by more Water from above, is forced to riſe up into the Mould lying upon it, which it fills as a Ciſtern does a Fountain (or *Jet d'Eau*). The Land of ſuch an Hill is not the leſs wet or ſpewy for being laid up in Ridges, if they be made from the higher to the lower Part of the Field; for the Force of the Water's Weight continued will raiſe it ſo, as to cauſe it to iſſue out at the very Tops of thoſe Ridges; the Earth becomes a ſort of Pap or Batter, and being like a Quagmire, in going over it, the Feet of Men and Cattle ſink in till they come to the Clay.

There are Two Methods of draining ſuch a wet Hill: The one is to dig many Trenches croſs the Hill horizontally *(a)*, and either fill them up with Stones looſe or Archwiſe, through which the Water, when it ſoaks into the Trenches, may run off at one or both Ends of them into ſome Ditch, which is lower,

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(a) For if they are made with the Deſcent, and not acroſs it, then they will be parallel to the Rills of Water, that run upon the Surface of the Clay under the Staple (or upper *Stratum* of Mould) and would be no more effectual for draining the Hill, than the digging of one River parallel to another, without joining it in any Part, would be effectual for draining the other River of its Water.

and carries it away; then they cover the Trenches with Mould, and plow over them as in dry level Ground.

This Method has been found effectual for a time, but not of long Continuance; for the Trenches are apt to be ſtopp'd up, and then the Springs break out again as before: Beſides, this is a very chargeable Work, and in many Places the Expence of it may almoſt equal the Purchaſe of the Land.

Therefore 'tis a better Method to plow the Ridges croſs the Hill almoſt horizontally, that their parting Furrows, lying open, may each ſerve as a Drain to the Ridge next below it; for when the Plough has made the Bottom of theſe horizontal Furrows a few Inches deeper than the Surface of the Clay, the Water will run to their Ends very ſecurely, without riſing into the Mould, provided no Part of the Furrows be lower than their Ends.

Theſe parting Furrows, and their Ridges, muſt be made more or leſs oblique, according to the Form and Declivity of the Hill; but the more horizontal they are, the ſooner the Rain-water will run off the Lands; for in that Caſe it will run to the Furrows, and reach them at right Angles, which it will not do when the Ridges (or Lands) are oblique; and therefore the Water's Courſe croſs the Lands will be longer (*a*). Every one of theſe horizontal Trenches receives

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(*a*) The natural Courſe of Water being downwards, it would always run by the neareſt Way to the Bottom of the Hill, if nothing ſtopt it; but the Water runs from an Hill in Two Manners; *viz.* Upon the Surface of the Staple, and upon the Surface of the Clay that is under the Staple; that which runs under keeps its ſtrait Courſe from the Top to the Bottom of an Hill, under a Ridge that is made exactly with the Deſcent of the Hill, except that Part of the Water that riſes up into the Mould, and a very little that ſoaks into the Furrows; for when the Furrows are not made exactly with the Deſcent, the more oblique they are to the Deſcent, the longer will be the Water's Courſe under the Ridges; and the ſhorter, as they are nearer being at Right Angles to the Deſcent.

receives all the Water from the Rills, or little Gutters, wherein the Water runs betwixt the Mould and the Clay; theſe are all cut off by the Trenches, which receive the Water at their upper Sides, and carry it away, as the Trunks of Lead plac'd under the Eaves of a Houſe do carry away the Rain-water.

If there were no other Manner of plowing Ridges on the Sides of Hills than what is commonly practiſed on the Plains, this Method of leaving open Furrows (or Drains on Declivities) would be impracticable; becauſe the Plough could not turn up the Furrows againſt the Hill, and againſt the Ridge alſo, from the lower Side of it: But the eaſy Remedy againſt that Inconvenience is, to plow ſuch Ridges in Pairs, without throwing any Earth into the Trenches, and then the Ridges will be plain a-top, and the Rain-water will run ſpeedily downward to the next Trench, and thence to the Head-land, and ſo out of the Field. Theſe Trenches will be made, as well as kept always open, by this plowing in Pairs; and is abundantly more eaſy than the Way of plowing Ridges ſingly. This plowing in Pairs prevents alſo another Inconveniency, which would otherwiſe happen to theſe horizontal Ridges; and that is, they being higheſt in the Middle, the Rain-water could not run freely from the upper Half of a Ridge towards the next Furrow below it, but would be apt to ſink in there, and ſoak thro' the Ridge; but when Ridges lie in Pairs, the Water will run off from a whole Ridge, as well as off the lower Half of a Ridge that is plow'd ſingly, and higheſt in the Middle.

Deſcent. 'Tis alſo the ſame with the Water that falls upon the Surface of the Ridges; for the more horizontal they are, the ſhorter its Courſe will be from them to the Furrows, which carry it off; and the leſs of the Water will ſink into the Ridges, the leſs oblique and the nearer to Right Angles to the Deſcent they are made.

Note, That every time of plowing, the Pairs muſt be changed, ſo that the Furrow, which had Two Ridges turned towards it one time, muſt have Two turned from it the next time: This Method keeps the Surfaces of all the Ridges (or Lands) pretty near even (*a*).

Farmers are at more Trouble and Pains to drown ſuch Land (it being common to break their Horſes Wind in plowing up Hill) than they would be at, if they laid their Ridges in the aboveſaid Manner, which would effectually make them dry. Many hundred Acres of good Ground are ſpoiled; and many a good Horſe, in plowing againſt the Hill, and againſt all Reaſon, Demonſtration, and Experience too; which might be learned even from the *Iriſh*, who drain their Bogs, and make them fruitful, whilſt ſome *Engliſh* beſtow much Labour to drown and make barren many of their Hills, which would more eaſily be made dry and fertile.

I have obſerved, that thoſe Places of ſuch an Hill, that when plowed with the Deſcent, were the wetteſt, and never produced any thing that was ſown on them, became the very richeſt, when made dry by plowing croſs the Deſcent. This ſhews that Water does not impoveriſh Land, but the contrary; tho', whilſt it ſtands thereon, it prevents the Heat which is neceſſary to the Production of moſt ſorts of Vegetables: And where it runs ſwiftly, it carries much Earth away with it; where it runs ſlowly, it depoſits and leaves much behind it.

Though in all Places, where this Way of making the Ridges croſs the Deſcent of Hills is practiſed, the Land becomes dry; yet very few Farmers will

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(*a*) *Note*, This cannot be done on an Hill, whoſe Declivity is ſo great, that the Plough is not able to turn a Furrow againſt it. But in this caſe, perhaps, it may be ſufficient to plow the Ridges obliquely enough for the Furrow to be turned both Ways.

alter their old Method (*a*); no, not even to try the Experiment; but ſtill complain their Ground is ſo wet and ſpewy, that it brings them little or no Profit; and if the Year prove moiſt, they are great Loſers by ſowing it (*b*).

(*a*) But ſome of late are convinced, by obſerving that an Hill of mine has been made dry by this means for Fourteen Years paſt, which before was always more wet and ſpewy than any Field in the Neighbourhood; and from the time of incloſing it out of an Heath (or Common), and the converting it to arable, which was about Seventy Years ago, it had been reputed as little better than barren, on account of its Wetneſs; and that it has been the moſt profitable Field of my Farm ever ſince it has been under this new Management. I have alſo another Field, that lies about a Mile and an half from me: It doth not belong to the Farm where I live, but was thrown upon my Hands, no Tenant caring to rent it, becauſe great Part of it was full of Springs, and barren: This alſo, having been kept in Lands plowed croſs the Deſcent (which is but a ſmall Declivity), is become dry: And now the moſt prejudiced Farmers agree, that keeping the Lands or Ridges of wet Ground always croſs the Deſcent doth cure its Spewineſs. Hereupon ſome have attempted to put this Method in Practice on their wet Land; and, after it has been well tilled up Hill and down, have plowed it the laſt time for ſowing of Wheat, in flat Lands croſs the Deſcent; but by Miſmanagement their Furrows are higher at each End than the Middle, ſo that none of the Water can run off either downwards or ſideways, or any other Way.

Had the Furrows carried off the Water at both or either of their Ends, it might have been effectual, notwithſtanding the broad Lands, becauſe their Ground hath a much leſs Declivity, and is much leſs ſpewy, than my Hill was: They will doubtleſs find their Miſtake, and amend it, having a Precedent before their Eyes; but if they had none within their own Inſpection, I queſtion whether this Miſmanagement might not diſcourage them from proſecuting their Project any further.

(*b*) Remember, in making Ridges of all Sorts, and of whatſoever Figure the Piece is, that no Ridge ought to have any more Furrows at one End, than at the other End; for if there be, the Plough muſt be turned in the Middle of the Piece, which will cauſe the Land to be trodden by the Horſes; but if each End have an equal Number of Furrows, the Horſes in turning will tread only upon the Head-lands, which may be plowed afterwards; or if deſign'd to be Horſe-ho'd, the Head-lands ſhould be narrow, and not plowed at all.

The Benefit of laying up ſtrong deep Land into Ridges is very great; tho' there be no Springs in it, as are in the Hills aforementioned.

This Land, when it lies flat, and is plowed ſometimes one Way, ſometimes the other, by croſs-plowing, retains the Rain-water a long time ſoaking into it; by that Misfortune, the Plough is kept out Two or Three Weeks longer than if the ſame were in round Ridges; nay, ſometimes its Flatneſs keeps it from drying till the Seaſon of plowing, and even of ſowing too, be loſt.

The Reaſons commonly given againſt ſuch Ridges are theſe following.

I. *They prevent the fanſied Benefit of croſs-plowing.*

II. *Farmers think they loſe Part of their Ground, by leaving more Furrows betwixt Ridges, than when they lay their Land flat, where the Lands are made much larger than round Ridges can conveniently be; and becauſe alſo the Furrows betwixt Ridges muſt be broader, and lie open; but the other they fill up by the Harrows.*

The Firſt of theſe I have already anſwered elſewhere, by ſhewing, that Croſs-plowing is oftener injurious than beneficial.

The Second I ſhall ſufficiently confute, if I can make appear, that no Ground is loſt, but much may be gained, by Ridges.

What I mean by gaining of Ground, is the increaſing of the Earth's Surface: For if a flat Piece be plow'd up into Ridges, and if in each Sixteen Feet Breadth there be an empty Furrow of Two Feet; and yet, by the Height and Roundneſs of the Ridges, they have Eighteen Feet of Surface capable of producing Corn equally to Eighteen Feet, whilſt the Piece was flat; there will be one Eighth Part of profitable Ground or Surface gain'd, more than it had when level; and this, I believe, Experience will prove, if the thing were well examined into.

But againſt this Increaſe of profitable Ground, there is an Objection, which I muſt not call a frivolous one, in reſpect to the Authors who bring it; yet, I hope, the Deſire of finding the Truth, will juſtify me to examine it; and the Arguments brought to ſuſtain it.

This Opinion of theirs is founded upon their Notion (which I think very erroneous) of the perpendicular Growth of Vegetables; and is, by Mr. *Bradley*, ſet in its beſt Light, in his *Vol.* I. *Pag.* 8. *uſque ad Pag.* 13. and in his Cuts, repreſenting Three Hills; but his Arguments ſeem to be ſuch, as all Arguments are, which pretend to prove a thing to be what it is not; *viz.* Sophiſtical ones.

The Hypotheſis he endeavours to prove, is in *Pag.* 8. thus: 'An Hill may contain Four equal Sides, 'which meet in a Point at the Top; but the Contents 'of theſe Four Sides can produce no more, either 'of Grain or Trees, than the plain Ground, upon 'which the Hill ſtands, or has at its Baſe; and yet, 'by the Meaſure of the Sides, we find twice the 'Number of Acres, Roods, and Poles, which meaſures in the Baſe, or Ground-plat; and therefore '*Page* 9. Hills are worth no more than half their 'Superficial Meaſure; *i. e.* Two Acres upon the 'Side of the Hill to pay as much as one upon the 'Plain, provided the Soil of both is equally rich.'

To prove it, he gives an Example in *Fig.* III. of Buildings upon an Hill; ſhewing, that the Two Sides of the Hill will only bear the ſame Number of Houſes, that may ſtand in the Line at the Baſe.

This is foreign to the Queſtion, of how much Grain, or how many Trees, the Hill will produce. For Vegetables, being fed by the Earth, require much more of its Surface to nouriſh them, than is neceſſary for them to ſtand on; but Buildings require no more of the Surface but Room to ſtand on: Therefore no ſuch Argument, taken from Buildings, can be applied to Vegetables.

This Argument of Mr. *Bradley*'s gives no more Satisfaction to the Queſtion about producing of Vegetables, than a Grazier would do, being aſked, how many Oxen a certain Paſture-ground would maintain, if he ſhould anſwer, by ſatisfying you with the Number of Churches which might ſtand thereon.

The like Anſwer, in effect, may be given to the Argument in *Fig*. IV. of the Pales; only he has forgot to ſhew, that to mound over the Hill would require double the Rails, or double the Hedge-wood (except Stakes) as to mound the Baſe; if it did not, the Hill would be yet of the more Value, becauſe thereon more Surface might be fenced in at leſs Expence.

In his *Fig*. II. he gives no good Reaſon why the Hill ſhould not bear twice the Number of Trees as the Baſe can do; for there is as much Room for Two hundred Trees on the Hill, as for One hundred on the Baſe, becauſe he allows the Surface to be double to that of the Baſe. He ought to meaſure the Diſtances of the Trees on the Hill, by a Line parallel to the Surface they grow on, as well as he does the Diſtances of thoſe below.

And ſuppoſe the Row at the Baſe, together with the Surface they grow on, were rais'd up, ſo that it ſhould become parallel to half the Row on the Hill, would not the Trees in the Baſe Row be twice as near to one another as the Trees in the Hill Row are? And ſuppoſe a Line had been ty'd from the Tops of all the lower Trees before the Row was ſo rais'd up at one End, and then after the Situation of the Row was ſo alter'd, if by this Line the Trees ſhould be pull'd from being perpendicular to the Surface they grow on, and made to ſtand oblique to that, and perpendicular to the Horizon, as the upper Trees are; would the Diſtances of the Trees from one another be alter'd by this Change of Poſture? No; for their Bottoms would be at the ſame Diſtances, becauſe not removed; and their Tops, becauſe the ſame Line holds them, at the ſame Diſtances in both Poſtures.

Mr. *Bradley*'s Lines, drawn from the Trees below, which are one Perch aſunder, make the Two Rows of Trees falſly ſeem to be at equal Diſtances, becauſe theſe Lines are parallel to each other: But this is a Deceit; for, in Truth, the Diſtances of the Trees are not meaſured by the Diſtances of thoſe Lines, but by the extreme Points at the Ends of the Lines *(a)*; and thoſe Two Points above, where the Lines cut the Row obliquely, and at unequal Angles, are twice as far aſunder as the endmoſt or extreme Points below are, where the Lines cut the Row at right Angles. Hence may be inferr'd, that there is Room for twice as many Trees to grow on the Hill as on the Baſe, and twice as much Grain for the ſame Reaſon; becauſe there is twice the Surface for the Roots to ſpread in. And ſince Mr. *Bradley* allows the Hill to contain Two Perches to One of the Baſe, and the Soil of both to be of equal Goodneſs; and yet affirms, that the Two can produce no more of Grain or Trees, than the one Perch can; I cannot ſee, why it ſhould not be as reaſonable to ſay, that Two Quarters of Oats will maintain an Horſe no longer, nor better, than One Quarter of Oats, of equal Goodneſs, will do.

In *Page* 13. he concludes thus: 'That Hills, in 'their Meaſure, contain only as much profitable 'Land as the Plain or Plat of Ground they ſtand 'upon; and as a Proof of that, all Vegetables or 'Plants have an erect Method of Growth.'

This Proof of Mr. *Bradley*'s is founded upon an Argument which has no Conſequence, unleſs it were

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(a) Theſe upper Trees are meaſured by the unequal Length of the Lines, not by their parallel Diſtance, as the lower Trees are; therefore his Meaſure is a Quibble.

firſt proved, that the Surface of Earth could produce and maintain as many Vegetables or Plants as could ſtand thereon in an erect Poſture; which Suppoſition is as impoſſible, as that half an Acre ſhould produce and maintain an Hecatomb, without Mr. *Bradley*'s teaching Oxen to live upon Air for their Food, as he thinks *Van Helmont*'s Tree did.

All expert Huſbandmen muſt needs be convinced, that the greateſt Crop of Vegetables that ever grew, might ſtand in an erect Poſture, upon a twentieth (and I may ſay the hundredth) Part of the Surface that produced it; therefore there muſt be Nineteen Parts for the Roots to ſpread, unoccupied by the Trunks, Stems, or Stalks.

And tho' it be true, that an Hill will ſupport no more of theſe, than its Baſe, when placed in an erect Poſture, cloſe together, as in a Sheaf; yet this cloſe Poſition is only proper for them when they are dead, and require no more Nouriſhment than Houſes and Pales do; and conſequently require no Room but to ſtand on. Therefore this Argument of Mr. *Bradley*'s muſt not be admitted in vegetative Growth, where there is always required Nineteen times more Room in the Surface, for the Uſe of the Roots, than what the Stems, Trunks, or Stalks, do poſſeſs upon it: And the more Room there is for the Roots, the greater Number of Plants may be produced.

Neither can I admit, that all Vegetables or Plants have an erect Method of Growth; becauſe the contrary is ſeen in Chamomile, and divers other Vegetables, which have an horizontal Method of Growth.

But what is more material to this Purpoſe, to be obſerved, is, that all Vegetables have horizontal Roots, and Roots parallel to the Earth's Surface or Superficies; and unleſs thoſe Roots have a ſufficient Superficies of Earth to range in, for Nouriſhment of a Plant, the Stem and Branches cannot proſper, whatever be their Method of Growth above the Earth; and if there be not a due Quantity of Food for the Roots within the Earth, a very little Space may contain the external Parts of Vegetables upon it.

From what has been ſaid, I think we may conclude, that Mr. *Bradley*'s Hill may produce more Vegetables than the Baſe whereon it ſtands; and therefore it is of more Value than half its ſuperficial Meaſure; *i. e.* Two Acres on the Hill are worth more than one Acre on the Plain, the Soil being equally rich, as he allows it to be, in his Caſe.

Now, indeed, whether Mr. *Bradley* might not poſſibly be deceived in his Opinion of the equal Richneſs of his Hill, and his Plain, I will not diſpute: I will only ſay this, that 'tis generally otherwiſe. But where a Plain is plow'd up into moderate Ridges, their Height being in proportion to the Depth of the Staple, below which the Plough muſt take nothing into the Ridges, the Soil is equally rich, whether it be plowed plain, or ridged up. And as the Surface is in the Ridges increaſed, there is nothing in all Mr. *Bradley*'s Arguments, that ſhews, why that increaſed Surface ſhould not produce more Vegetables than the ſame Earth could do whilſt it was level.

There are other Reaſons why it ſhould produce more when ridged (*a*), beſides the Increaſe of Surface; as,

I. *'Tis then more free from the Injuries of too much Water.*

(*a*) To the Three we may add a Fourth Reaſon, *viz.* the raiſing the Thickneſs of the Staple in the Ridges, keeping the Surface drier in wet Weather, and moiſter at the Bottom of the Staple in dry Weather. And I have ſeen Barley that was drilled on my raiſed little Ridges flouriſh in a dry Summer on the Brow of my chalky Hill, and on my loweſt Land in wet Weather, when the Barley hand-ſown contiguous to it on each ſide thoſe Ridges, ſown on the Level the ſame Day that the Ridges were drilled, have looked yellow and ſickly; and yet it is not wet Land.

II. *'Tis better protected againſt cold Winds; becauſe the Ridges are a Shelter to one another.*

III. *If the Surface be much exhauſted, by too frequent Sowing, the Ridges may be made juſt where the Furrows were, and then the Surface will be intirely changed.*

The following general Rules ought to be obſerved about Ridges; *viz.*

That, as to their Height, regard muſt be had to the Nature of the Soil, in its difficult Admiſſion of Water; for the greater that is, the greater Declivities the Ridges ſhould have; and then, if the Soil be not deep, they ſhould generally be made the narrower.

There is one thing which Mr. *Bradley* takes no notice of; *viz.* That no more of the Rain, or other Benefits of the Atmoſphere, which deſcend perpendicularly, can fall on an Hill, or on a Ridge, than what would fall on the Baſe, or Ground-plot. But 'tis probable, that more of the fine Vapour, which ſwims in the Current of the Air horizontally, does ſtrike and break againſt thoſe Eminences, and ſo make an Equivalent (*b*), except that it runs off more quickly.

Notwithſtanding all I have here ſaid, in behalf of Ridges, I muſt confeſs, that for my Hoeing-Huſbandry, I ſhould prefer Land that is naturally dry enough, without a Neceſſity of being laid up in any larger or higher Ridges than what many contain Six Feet in Breadth (*c*), that Size being the largeſt that is proper for the regular Operation of the Horſe-hoe.

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(*b*) But though Ridges do alter or increaſe the Surface, the Quantity of Soil or Earth remaining the ſame as on the Level, and of no greater Depth than can be tilled, it may produce equal Crops of Corn with the Level, and no more; except from the Advantage the Ridges may give it in lying drier.

(*c*) Since the Printing of my Eſſay, I find upon Trial, that theſe narrow Ridges are as effectual as any for carrying the Water off from my clayey Hill; and that they may be made much leſs horizontal

CHAP. XVII.

Of Differences *between the* Old *and the* New Huſbandry.

IN order to make a Compariſon between the Hoeing-Huſbandry, and the old Way, there are Four Things; whereof the Differences ought to be very well conſidered.

I. *The Expence*
II. *The Goodneſs* } of a Crop.
III. *The Certainty*
IV. *The Condition in which the Land is left after a Crop.*

The Profit or Loſs ariſing from Land, is not to be computed, only from the Value of the Crop it produces; but from its Value, after all Expences of Seed, Tillage, *&c.* are deducted.

Thus, when an Acre brings a Crop worth *Four Pounds*, and the Expences thereof amount to *Five Pounds*, the Owner's Loſs is *One Pound*; and when an Acre brings a Crop which yields *Thirty Shillings*, and the Expence amounts to no more than *Ten Shillings*, the Owner receives *One Pound*, clear Profit, from this Acre's very ſmall Crop, as the other loſes *One Pound* by his greater Crop.

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horizontal than broad Ridges, whereby their Furrows are the more eaſily turned upwards againſt the Declivity.

I have not tried any narrower Ridges than of Six Feet upon this Hill: But I have had full Experience of Five-feet and of Four-feet Ridges upon other Land; and find that all Sizes of theſe narrow Ridges are very advantageous, even where the Crop is to be ſown upon the Level; for fewer Furrows are neceſſary for the Tilling of an Acre, when 'tis kept in ſuch Ridges, than in broad Lands; and after wet Weather the Ridges will be fit to be plowed much ſooner than level Ground.

The uſual Expences of an Acre of Wheat, ſown in the old Huſbandry, *in the Country where I live, is, in ſome Places, for Two Buſhels and an half of Seed; in other Places Four Buſhels and an half; the leaſt of theſe Quantities at* Three Shillings per *Buſhel, being the preſent Price, is* Seven Shillings *and* Six-pence. *For Three Plowings, Harrowing, and Sowing,* Sixteen Shillings; *but if plow'd Four times, which is better,* One Pound. *For Thirty Load of Dung, to a Statute Acre, is* Two Pounds Five Shillings. *For Carriage of the Dung, according to the Diſtance, from* Two Shillings *to* Six-pence *the Load,* One Shilling *being the Price moſt common, is* One Pound Ten Shillings. *The Price for Weeding is very uncertain; it has ſometimes coſt* Twelve Shillings, *ſometimes* Two Shillings per *Acre.*

	l.	*s.*	*d.*
In Seed and Tillage, nothing can be abated of — — —	01	03	06
For the Weeding, one Year with another, is more than — —	00	02	00
For the Rent of the Year's Fallow	00	10	00
For the Dung; 'tis in ſome Places a little cheaper, neither do they always lay on quite ſo much; therefore abating 15*s. in that Article, we may well ſet Dung and Carriage at* — — —	02	10	00
Reaping commonly 5 *s. ſometimes leſs*	00	04	06
Total	04	10	00

Folding of Land with Sheep is reckoned abundantly cheaper than Cart-dung; but this is to be queſtioned, becauſe much Land muſt lie ſtill for keeping a Flock (unleſs there be Downs); and for their whole Year's keeping, with both Graſs and Hay, there are but Three Months of the Twelve wherein the Fold is of any conſiderable Value; this makes the Price of their Manure *quadruple to what it would be, if equally good all the Year, like Cart-dung: And folding Sheep yield little Profit, beſides their Dung; becauſe the Wool of a Flock, except it be a large one, will ſcarce pay the Shepherd and the Shearers. But there is another thing yet, which more inhances the Price of Sheep-dung; and that is, the dunging the Land with their Bodies, when they all die of the Rot, which happens too frequently in many Places; and then the whole Crop of Corn muſt go to purchaſe another Flock, which may have the ſame Fate the enſuing Year, if the Summer prove wet; and ſo may the Farmer be ſerved for ſeveral more ſucceſſive Years, unleſs he ſhould break, and another take his Place, or that dry Summers come in time to prevent it. To avoid this Misfortune, he would be glad to purchaſe Cart-dung at the higheſt Price, for ſupplying the Place of his Fold; but 'tis only near Cities, and great Towns, that a ſufficient Quantity can be procured.*

But, ſuppoſing the Price of Dunging to be only Two Pounds Ten Shillings, and the general Expence of an Acre of Wheat, when ſown, at Three Shillings per *Buſhel, to be Four Pounds Ten Shillings, with the Year's Rent of the Fallow;*

The Expences of planting an Acre of Wheat in the Hoeing-Huſbandry, is Three Pecks (*a*) of Seed; at *Three Shillings per* Buſhel, is *Two Shillings* and *Three-pence*. The whole Tillage, if done by Horſes, would be *Eight Shillings*; becauſe our Two Plowings, and Six Hoeings (*b*), are equal to Two Plowings; the

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(*a*) Sometimes half a Buſhel is the moſt juſt Quantity of Seed, to drill on an Acre.

(*b*) But we ſometimes plow our Six-feet Ridges before Drilling, at Five or Six Furrows, which is a Furrow or Two more than I have reckoned: But we do not always hoe Six times afterwards. But it is better for ſucceſſive Wheat-crops to beſtow the Labour of as many Hoeings as amount to three plain Plowings in a Year, it being a greater Damage to omit one neceſſary Hoeing, than is the Expence of ſeveral Hoeings.

the common Price whereof is *Four Shillings* each; but this we diminiſh half, when done by Oxen kept on St. Foin, in this manner; *viz.* Land worth *Thirty Shillings* Rent, drill'd with St. Foin, will well maintain an Ox a Year *(a)*, and ſometimes Hay will be left to pay for the Making: We cannot therefore allow more than *One Shilling* a Week for his Work, becauſe his keeping comes but to *Seven-pence* a Week round the Year.

In plain Plowing, Six Feet contains Eight Furrows; but we plow a Six-feet Ridge at Four Furrows, becauſe in this there are Two Furrows cover'd in the Middle of it, and one on each Side of it lies open. Now what we call one Hoeing, is only Two Furrows of this Ridge, which is equal to a Fourth Part of one plain Plowing; ſo that the Hoeing of Four Acres requires an equal Number of Furrows with One Acre, that is plow'd plain, and equal time to do it in (except that the Land, that is kept in Hoeing, works much eaſier than that which is not).

All the Tillage we ever beſtow upon a Crop of Wheat that follows a ho'd Crop, is equal to Eight Hoeings *(b)*; Two of which may require Four Oxen each, One of them Three Oxen, and the other Five Hoeings Two Oxen each. However, allow Three Oxen to each ſingle Hoeing, taking them all one with another, which is Three Oxen more than it comes to in the Whole.

(*a*) Or an Ox may be well kept Nine Months, with an Acre of indifferent Horſe-ho'd Turneps; and if we value them only at the Expence and Rent of the Land, this will be a yet cheaper Way of maintaining Oxen. Upon more Experience it is found, that St. Foin Hay alone, or with a ſmall Quantity of Turneps, is beſt for working Oxen in the Winter; but a Plenty of Turneps with the ſame Hay is better for fatting Oxen that do not work.

(*b*) But the Number of Oxen required will be according to their Bigneſs and Strength, and to the Depth and Strength of the Soil which alſo will be the eaſier Draught for the Oxen, the oftener the Intervals are hoed.

Begin at Five in the Morning, and in about Six Hours you may hoe Three Acres, being equal in Furrows to Three Rood; *i. e.* Three Quarters of an Acre. Then turn the Oxen to Graſs, and after reſting, eating, and drinking, Two Hours and an half, with another Set of Oxen begin Hoeing again; and by or before half an Hour after Seven at Night, another like Quantity may be ho'd. Theſe are the Hours the Statute has appointed all Labourers to work, during the Summer Half-year.

To hoe theſe Six Acres a Day, each Set of Oxen draw the Plough only Eight Miles and a Quarter, which they may very well do in Five Hours; and then the Holder and Driver will be at their Work of Plowing Ten Hours, and will have Four Hours and an half to reſt, *&c.*

The Expence then of hoeing Six Acres in a Day, in this manner, may be accounted, at *One Shilling* the Man that holds the Plough, *Six-pence* the Boy that drives the Plough, *One Shilling* for the Six Oxen, and *Six-pence* for keeping the Tackle in Repair. The whole Sum for hoeing theſe Six Acres is *Three Shillings*, being *Six-pence per* Acre (*a*).

They who follow the old Huſbandry cannot keep Oxen ſo cheap, becauſe they can do nothing without the Fold, and Store-ſheep will ſpoil the St. Foin. They may almoſt as well keep Foxes and Geeſe together, as Store-ſheep and good St. Foin. Beſides, the ſowed St. Foin coſt Ten times as much the Planting as drill'd St. Foin does, and muſt be frequently manured, or elſe it will ſoon decay; eſpecially upon all ſorts of chalky Land, whereon 'tis moſt commonly ſown.

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(*a*) But where there is not the Convenience of keeping Oxen, the Price of Hoeing with Horſes is One Shilling each time.

When a Roller is uſed, which is leſs than a Hoeing, becauſe one Perſon to lead is enough, and that may be a Boy; and once in an Interval may ſuffice; then 'tis leſs Labour than half a Hoeing; and for this we may well abate One Hoeing of the Eight.

The Expence of Drilling cannot be much; for as we can hoe Six Acres a Day, at Two Furrows on each Six-feet Ridge, ſo we may drill Twenty-four Acres a Day, with a Drill that plants Two of thoſe Ridges at once; and this we may reckon a *Peny Halfpeny* an Acre. But becauſe we find it leſs Trouble to drill ſingle Ridges, we will ſet the Drilling, at moſt, *Six-pence per* Acre.

As every ſucceſſive Crop (if well managed) is more free from Weeds than the preceding Crop; I will ſet it all together at *Six-pence (a)* an Acre for Weeding *(b)*.

For a Boy or a Woman to follow the Hoe-plough, to uncover the young Wheat, when any Clods of Earth happen to fall on it, for which Trouble there is ſeldom neceſſary above once *(c)* to a Crop, *Two-pence* an Acre. *One Peny* is too much for Brine and Lime for an Acre.

Reaping this Wheat is not worth above half as much as the Reaping of a ſown Crop of equal Value; becauſe the drill'd ſtanding upon about a Sixth Part of the Ground, a Reaper may cut almoſt as much of the Row at one Stroke, at he could at Six, if the ſame ſtood diſperſed all over the Ground, as the ſowed does; and becauſe he who reaps ſowed Wheat,

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(*a*) This is when the Land has been well cleanſed of Weeds in the preceding Crop, or Fallow, or both.

(*b*) This may be enough, if the Land be well cleanſed the Year before, and conſidering that ſeveral Years in ſuch there is no Occaſion for Weeding at all: And as this Calculation is comparative with the old Way, we ſhould examine the Price of weeding the ſown Corn, which, by the beſt Information I can get, was in the Year 1735. about 4*s.* *per* Acre for Weeding of Barley; and of Wheat, round about where I live, about 6*s.* and in *Wiltſhire*, 15*s.* *per* Acre for their Wheat, amongſt which much Damage is done by the Weeder's Feet, and yet ſome Weeds are left.

(*c*) But this Expence being ſo ſmall, 'tis better that a Perſon ſhould follow at every Hoeing, where we ſuſpect, that any Damage may happen from any Earth's falling on, or preſſing too hard againſt ſome of the Plants.

muſt reap the Weeds along with the Wheat; but the drilled has no Weeds; and beſides, there go a greater Quantity of Straw, and more Sheaves, to a Buſhel of the ſowed, than of the drilled *(a)*. And ſince ſome Hundred Acres of drilled Wheat have been reaped at *Two Shillings* and *Six-pence per* Acre, I will count that to be the Price.

The whole Expence *of an Acre of drilled Wheat.*

	l.	*s.*	*d.*
For Seed — — — — —	00	02	03
For Tillage — — — —	00	04	00
For Drilling — — — —	00	00	06
For Weeding — — — —	00	00	06
For Uncovering — — —	00	00	02
For Brine and Lime — —	00	00	01
For Reaping — — — —	00	02	06
Total	00	10	00
The Expence of an Acre of ſowed Wheat is - - - - -	04	00	00
To which muſt be added, for the Year's Rent of the Fallow	00	10	00
Total	04	10	00

If I have reckon'd the Expence of the drilled at the loweſt Price, to bring it to an even Sum; I have alſo abated in the other more than the whole Expence of the drilled amounts unto.

And thus the Expence of a drilled Crop of Wheat is but the Ninth Part of the Expence of a Crop ſown in the common Manner.

'Tis alſo ſome Advantage, that leſs Stock is required where no Store-ſheep are uſed.

(*a*) One Sheaf of the latter will yield more Wheat than Two of the former of equal Diameter.

II. *Of the different Goodneſs of a Crop.*

The Goodneſs of a Crop conſiſts in the Quality of it, as well as the Quantity; and Wheat being the moſt uſeful Grain, a Crop of this is better than a Crop of any other Corn, and the ho'd Wheat has larger Ears (and a fuller Body) than ſow'd Wheat. We can have more of it, becauſe the ſame Land will produce it every Year, and even Land, which, by the Old Huſbandry, would not be made to bear Wheat at all: So that, in many Places, the New Huſbandry can raiſe Ten Acres of Wheat for One that the Old can do; becauſe where Land is poor, they ſow but a Tenth Part of it with Wheat.

We do not pretend, that we have always greater Crops, or ſo great as ſome ſown Crops are, eſpecially if thoſe mention'd by Mr. *Houghton* be not miſtaken.

The greateſt Produce I ever had from a ſingle Yard in Length of a double Row, was Eighteen Ounces: The Partition of this being Six Inches, and the Interval Thirty Inches, was, by Computation, Ten Quarters (or Eighty Buſhels) to an Acre.

I had alſo Twenty Ounces to a like Yard of a Third ſucceſſive Crop of Wheat; but this being a treble Row, and the Partitions and Interval being wider, and ſuppoſed to be in all Six Feet, was computed to Six Quarters to an Acre. And if theſe Rows had been better order'd than they were, and the Earth richer, and more pulveriz'd, more Stalks would have tillered out, and more Ears would have attained their full Size, and have equall'd the beſt, which muſt have made a much greater Crop than either of theſe were.

But to compare the different Profit, we may proceed thus: The Rent and Expence of a drill'd Acre being One Pound, and of a ſow'd Acre Five Pounds; One Quarter of Corn, produced by the drill'd, bears an equal Proportion in Profit to the One Pound, as Five Quarters, produced by the other, do to the Five

Pounds. As ſuppoſe it be of Wheat, at Two Shillings and Six-pence a Buſhel, there is neither Gain nor Loſs in the one nor the other Acre, though the former yield but One Quarter, and the other Five; but if the drill'd Acre yield Two Quarters, and the ſow'd Acre Four Quarters at the ſame Price, the drill'd brings the Farmer One Pound clear Profit, and the ſown, by its Four Quarters, brings the other One Pound Loſs. Likewiſe ſuppoſe the drilling Farmer to have his Five Pounds laid out on Five Acres of Wheat, and the other to have his Five Pounds laid out on One dung'd Acre; then let the Wheat they produce be at what Price it will, if the Five Acres have an equal Crop to the One Acre, the Gain or Loſs muſt be equal: But when Wheat is cheap, as we ſay it is when ſold at Two and Six-pence a Buſhel, then if the Farmer, who follows the old Method, has Five Quarters on his Acre, he muſt ſell it all to pay his Rent and Expence; but the other having Five Quarters on each of his Five Acres, the Crop of One of them will pay the Rent and Expence of all his Five Acres *(a)*, and he may keep the remaining Twenty Quarters, till he can ſell them at Five Shillings a Buſhel, which amounts to Forty Pounds, wherewith he may be able to buy Four of his Five Acres at Twenty Years Purchaſe, out of One Year's Crop, whilſt the Farmer who purſues the old Method, muſt be content to have only his Labour for his Travel; or if he pretends to keep his Wheat till he ſells it at Five Shillings a Buſhel, he commonly runs in Debt to his Neighbours, and in Arrear of his Rent; and if the Markets do not riſe in time, or if his Crops fail

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(*a*) Or ſuppoſe a drill'd Acre to produce no more than One Third of the ſow'd Acre's Crop, whoſe Expence is Five times as much as of the drill'd, 'tis much more profitable, becauſe a Third of Five Pounds is One Pound Thirteen and Four-pence; and a Fifth of the Rent and Expence being only One Pound, ſuch drill'd Acre pays the Owner Thirteen and Four-pence more Profit, than the other which brings a Crop treble to the drill'd.

fail in the Interim, his Landlord ſeizes on his Stock, and then he knows not how it may be ſold; Actions are brought againſt him; the Bailiffs and Attorneys pull him to Pieces; and then he is undone (*a*).

III. *The Certainty of a Crop.*

The Certainty of a Crop is much to be regarded, it being better to be ſecure of a moderate Crop, than to have but a mere Hazard of a great one. The Farmer who adheres to the old Method is often deceiv'd in his Expectation, when his Crop at coming into Ear is very big, as well as when 'tis in Danger of being too little. Our hoeing Farmer is much leſs liable to the Hazard of either of thoſe Extremes; for when his Wheat is big, 'tis not apt to lodge or fall down, which Accident is uſually the utter Ruin of the other; he is free from the Cauſes which make the contrary Crop too little.

A very effectual Means to prevent the failing of a Crop of Wheat, is to plow the pulveriz'd Earth for Seed early, and when 'tis dry. The early Seaſon alſo is more likely to be dry than the latter Seaſon is.

1. *The Advocate for the old Method is commonly*
late in his ſowing; becauſe he can't fallow his
Ground early, for fear of killing the Couch, and
other Graſs that maintains his folding Sheep, which
2. *are ſo neceſſary to his Huſbandry: And when 'tis*
ſow'd late, it muſt not be ſow'd dry, for then the
3. *Winter might kill the young Wheat. Neither can he*
at that time plow dry, and ſow wet, becauſe he com-
monly ſows under Furrow; that is, ſows the Seed
firſt, and plows it in as faſt as 'tis ſown. If he
4. *ſows early (as he may if he will) in light Land, he*
muſt not ſow dry, for fear the Poppies and other
Weeds ſhould grow, and devour his Crop; and if his
5. *Land be ſtrong, let it be ſown early, wet or dry (tho'*

(*a*) Tho' only Five Acres and One Acre be put, yet we may imagine them Two hundred and Fifty, and Fifty to enrich the one, or break the other Farmer.

wet is worſt), 'tis apt to grow ſo ſtale and hard by the Spring, that his Crop is in Danger of ſtarving, unleſs the Land be very rich, or much dung'd; and then the Winter and Spring proving kind, it may not be in leſs Danger of being ſo big as to fall down, and
6. *be ſpoil'd. Another thing is, that though he had no other Impediment againſt plowing dry, and ſowing wet, 'tis ſeldom that he has time to do it in; for he muſt plow all his Ground, which is Eight Furrows*
7. *in Six Feet; and, whilſt it is wet, muſt lie ſtill with his Plough. When he ſows under Furrow, he fears to plow deep, leſt he bury too much of his Seed; and*
8. *if he plows ſhallow, his Crop loſes the Benefit of deep plowing, which is very great. When he ſows*
9. *upon Furrow (that is after 'tis plow'd) he muſt harrow the Ground level to cover the Seed; and that expoſes the Wheat the more to the cold Winds, and ſuffers the Snow to be blown off it, and the Water to lie longer on it; all which are great Injuries to it.*

Our Hoeing Huſbandry is different in all of the fore-mentioned Particulars.

1. We can plow the Two Furrows whereon the next Crop is to ſtand, immediately after the preſent Crop is off.

2. We have no Uſe of the Fold; becauſe our Ground has annually a Crop growing on it, and it muſt lie ſtill a Year, if we would fold it, and that Crop would be loſt; and all the Good the Fold could do to the Land, would be only to help to pulverize it for one ſingle Crop; its Benefit not laſting to the Second Year. And ſo we ſhould be certain of loſing one Crop for the very uncertain Hopes of procuring one the enſuing Year by the Fold; when 'tis manifeſt by the adjoining Crops, that we can have a much better Crop every Year, without a Fold, or any other Manure.

3. We can plow dry, and drill wet, without any manner of Inconvenience.

4. He fears the Weeds will grow, and deſtroy his Crop: We hope they will grow, to the end we may deſtroy them (*a*).

5. We do not fear to plant our Wheat early (ſo that we plow dry), becauſe we can help the Hardneſs or Staleneſs of the Land by Hoeing.

6. The Two Furrows of every Ridge whereon the Rows are to be drill'd, we plow dry; and if the Weather prove wet before theſe are all finiſh'd, we can plow the other Two Furrows up to them, until it be dry enough to return to our plowing the firſt Two Furrows; and after finiſhing them, let the Weather be wet or dry, we can plow the laſt Two Furrows. We can plow our Two Furrows in the Fourth Part of the Time they can plow their Eight, which they muſt plow dry all of them, in every Six Feet; for they can't plow part dry, and the reſt when 'tis wet, as we can.

7. We never plant our Seed under Furrow, but place it juſt at the Depth which we judge moſt proper; and that is pretty ſhallow, about Two Inches deep; and then there is no Danger of burying it.

8. We not only plow a deep Furrow, but alſo plow to the Depth of Two Furrows; that is, we trench-plow where the Land will allow it (*b*); and we have the greateſt Convenience imaginable for doing this, becauſe there are Two of our Four Furrows

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(*a*) For, before they grow, they cannot be killed; but if they are all killed as ſoon as they appear, there will be no Danger of their exhauſting the Land, or re-ſtocking it with their Seed; and 'tis our Fault if we drill more than we can keep clean from Weeds by the Horſe-hoe, Hand-hoe, and Hands; the Firſt for the Intervals, the Second for the Partitions, and the Third for the Rows: By the Two former, as ſoon after they appear as they can; but by the laſt, when they are grown high enough to be conveniently taken hold of.

(*b*) Very little of my Land will admit the Plough to go the Depth of Two common Furrows without reaching the Chalk: But deep Land may be eaſily thus Trench-plowed with great Advantage; and even when there is only the Depth of a ſingle Furrow, that may ſometimes be advantageouſly plowed at twice.

always lying open; and Two plow'd Furrows (that is, one plow'd under another) are as much more advantageous for the nouriſhing a Crop, as Two Buſhels of Oats are better than One for nouriſhing an Horſe: Or if the Staple of the Land be too thin or ſhallow, we can help it by raiſing the Ridges prepar'd for the Rows the higher above the Level.

9. We alſo raiſe an high Ridge in the Middle of each Interval above the Wheat before Winter, to protect it from the cold Winds, and to prevent the Snow from being driven away by them. And the Furrows or Trenches, from whence the Earth of theſe Ridges is taken, ſerve to drain off the Water from the Wheat, ſo that, being drier, it muſt be warmer tha the harrow'd Wheat, which has neither Furrows to keep it dry, nor Ridges to ſhelter it (*a*), as every Row of ours has on both Sides of it.

IV. *The Condition in which the Land is left after a Crop.*

The different Condition the Land is left in after a Crop (*b*), by the one and the other Huſbandry, is not

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(*a*) This is a Miſtake; for the Ridges in the Middle of the Intervals do not always, nor often in thin ſhallow Land lie high enough to make a Shelter to the Rows, they being higher: But when Wheat is drilled on the Level, 'tis ſhelter'd by the Ridges raiſed in the Intervals: But we never weed or hand-hoe Wheat before the Spring.

(*b*) If indifferent Land be well pulverized by the Plough for one whole Year, it will produce a good Crop: But then, if, inſtead of being ſown, it be kept pulverized on for another Year without being exhauſted by any Vegetables, it will acquire from the Atmoſphere an extraordinary great Degree of Fertility more than it had before ſuch Second Year's Pulveration and Unexhauſtion. This being granted, which no Man of Experience can deny, what Reaſon can there be why ſuch a Number of Plants, competent for a profitable Crop, may not be maintained on it the Second Year, that may keep the Degree of their Exhauſtion in *Æquilibrio* with that Degree of Fertility, which the ſame Land had acquired at the End of the Firſt Year of its Pulveration, the ſame Degree of Pulveration being continued to it by Hoeing in the Second Year? Or why may it not produce annual Crops always, if the ſame *Equilibrium* be continually kept? Two unanſwerable not leſs conſiderable than the different Profit of the Crop.

A Piece of Eleven Acres of a poor, thin, chalky Hill was ſown with Barley in the common Manner, after a ho'd Crop of Wheat; and produced full Five Quarters and an half to each Acre (reckoning the Tythe); which was much more than any Land in all the Neighbourhood yielded the ſame Year; tho' ſome of it be ſo rich, as that One Acre is worth Three Acres of this Land: And no Man living can remember, that ever this produced above half ſuch a Crop before, even when the beſt of the common Management has been beſtow'd upon it.

A Field, that is a ſort of an Heath-ground, uſed to bring ſuch poor Crops of Corn, that heretofore the Parſon carried away a whole Crop of Oats from it, believing it had been only his Tythe. The beſt Management that ever they did or could beſtow upon it, was to let it reſt Two or Three Years, and then fallow and dung it, and ſow it with Wheat, next to that with Barley and Clover, and then let it reſt again; but I cannot hear of any good Crop that it ever produced by this or any other of their Methods; 'twas ſtill reckoned ſo poor, that nobody cared to rent it. They ſaid Dung and Labour were thrown away upon it; then immediately after Two ſown Crops of black Oats had been taken off it, the laſt of which was ſcarce worth the mowing, it was put into the

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able Reaſons may be given why this *Equilibrium* cannot be kept in the random Sowing, as it may in the Hoeing Method; *viz.* Firſt, In the former, the Land is by the Number of ſown Plants and Weeds much more (we may ſuppoſe at leaſt Five times more) exhauſted: And, Secondly, No Pulveration is continued to the Soil, whilſt the Crop is on it; which is that Part of the Year wherein is the moſt proper (if not the only proper) Seaſon for pulverizing. Therefore, allowing, that, in the random way, a Soil cannot, for want of Quantity of vegetable Food, continue to produce annual Crops without Manure, or perhaps with it; yet that is no Reaſon why it may not produce them in the Hoeing Culture duly performed.

Hoeing Management; and when Three ho'd Crops (*a*) had been taken from it, it was ſown with Barley, and brought a very good Crop, much better than ever it was known to yield before; and then a good Crop of ho'd Wheat ſucceeded the Barley, and then it was again ſown with Barley, upon the Wheat-ſtubble; and that alſo was better than the Barley it uſed to produce.

Now all the Farmers of the Neighbourhood affirm, that it is impoſſible but that this muſt be very rich Ground, becauſe they have ſeen it produce Six Crops in Six Years, without Dung or Fallow, and never one of them fail. But, alas! this different Reputation they give to the Land, does not at all belong to it, but to the different Sorts of Huſbandry; for the Nature of it cannot be alter'd but by that, the Crops being all carried off it, and nothing added to ſupply the Subſtance thoſe Crops take from it, except (what Mr. *Evelyn* calls) the celeſtial Influences; and that theſe are received by the Earth, in proportion to the Degrees of its Pulveration.

A Field was drilled with Barley after an ho'd Crop; and another adjoining to it on the ſame Side of the ſame poor Hill, and exactly the ſame ſort of Land, was drill'd with Barley alſo, Part of it after the ſown Crop, the ſame Day with the other; there was only this Difference in the Soil, that the former of theſe had no manner of Compoſt on it for many Years before, and the latter was dunged the Year before: Yet its Crop was not near ſo good as that which followed the ho'd Crop (*b*); tho' the latter had twice the Plowing that the former had before drilling, and the ſame Hoeings afterwards; *viz.* Each was ho'd Three times.

A Field of about Seventeen Acres was Summer-fallowed, and drilled with Wheat; and with the Hoeing brought a very good Crop (except Part of it,

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(*a*) Theſe Three ho'd Crops were of Turneps and Potatoes.

(*b*) This was a Wheat Crop, and often well ho'd.

which being eaten by treſpaſſing Sheep in the Winter, was ſomewhat blighted); the *Michaelmas* after that was taken off, the ſame Field was drilled again with Wheat, upon the Stubble of the former, and ho'd: This Second Crop was a good one, ſcarce any in the Neighbourhood better. A Piece of Wheat adjoining to it, on the very ſame ſort of Land (except that this latter was always reckoned better, being thicker in Mould above the Chalk), ſown at the ſame time on dung'd Fallows, and the Ground always dung'd once in Three Years; yet this Crop fail'd ſo much, as to be judged, by ſome Farmers, not to exceed the Tythe of the other: That the ho'd Field has receiv'd no Dung or Manure for many Years paſt, is becauſe it lies out of the Reach for carrying of Cart-Dung, and no Fold being kept on my Farm: But I cannot ſay, I think there was quite ſo much Odds betwixt this Second undung'd ho'd Crop and the ſown; yet this is certain, that the former is a good, and the latter a very bad Crop.

I could give many more Inſtances of the ſame Kind, where ho'd Crops and ſown Crops have ſucceeded better after ho'd Crops than after ſown Crops, and never yet have ſeen the contrary; and therefore am convinced, that the Hoeing *(a)* (if it be duly performed) enriches the Soil more than Dung and Fallows, and leaves the Land in a much better Condition for a ſucceeding Crop. The Reaſon I take to be very obvious:

(*a*) This is more eſpecially meant of Fallows in the common Huſbandry, and a moderate Quantity of common Dung, or the Fold: And there may be ſuch a poor Sand, or other barreniſh Soil, ſo ſubject to Conſtipation in the Winter, as to require Dung when planted with Wheat, there being no general Rule without Exceptions; and 'tis impoſſible for me to know the Number of theſe Exceptions. Well it is for the Hoer, whoſe Land is of ſuch a kind, that he can keep it in Heart without Dung by Hoeing; for when he has no Fold, he plows his Ground with Oxen, and plants it moſtly with Wheat, the Straw whereof being for other Uſes, he can make but very little Dung.

obvious: The artificial Paſture of Plants is made and increaſed by Pulveration only; and nothing elſe there is in our Power to enrich our Ground, but to pulverize it (*a*), and keep it from being exhauſted by Vegetables.

(*a*) Theſe Two are all we have in our Power; for pulverizing includes an Expoſure to the Atmoſphere; without which, I think, it cannot be reduced to Particles minute enough, or have their Superficies ſo impregnated as to become a fertile Paſture for Plants. The Experiment related by Mr. *Evelyn* of artificial Pulveration, ſeems to prove ſuch an Expoſure neceſſary; as alſo the frequent turning (or inceſſantly agitating) that fine Duſt for a Year, before the barren exhauſted Earth was made rich and prolific: For, beſides the Benefit of Pulveration and Impregnation, Land is more enriched in proportion to the Time of Expoſure, during which it is free from Exhauſtion, and continually receiving from the Atmoſphere: Therefore frequent Turning and Expoſure are both contained in the Words *pulverize, and not exhauſt*; and to comply with the latter, we ſhould endeavour, that our Land may be never exhauſted by any other Plants than by thoſe we would propagate, and by no more of them neither, than what are neceſſary for producing a reaſonable Crop; which, upon full Trial, will be found a very ſmall Number in compariſon to thoſe that are commonly ſown; and then, if the Supply from the Atmoſphere by Help of the Pulveration exceeds the Exhauſtion, the Land will become richer, tho' conſtant Crops are produced of the ſame Species; as in the Vineyards; and the Soil of theſe is ſo much improved by a bare competent Exhauſtion, and the uſual Pulveration, that after producing good annual Crops without Dung, until Age has killed the Vines, they leave the Soil better than they found it; and better than contiguous Land of the ſame Sort kept in arable Field-culture.

By Pulveration are meant all the Benefits of it that accrue to the Paſture of Plants; and by Exhauſtion, all the Injuries that can be done to that Paſture, except Burning. And as the Benefits of Pulveration viſibly continue for ſeveral Years, ſo do the Injuries of Exhauſtion; which appear by the Ends of ſome of my Rows that have been cleanſed of Weeds in their Partitions by the Hand-hoe, and the other Ends of the ſame Rows not cleanſed; the Difference is viſible in the Colour of the Wheat in the Third and Fourth following Crops, equally managed; and this is no more to be wondered at, than that Two unequal Sums, being equally increaſed or diminiſhed, ſhould remain unequal, until an Addition to the leſſer, or a Subtraction from the greater, be made; which, in caſe of the Soil, muſt be either by a greater Pulveration, or a leſſer Exhauſtion. 'Tis by this that both Ends of theſe Rows

in

getables *(a)*. Superinductions of Earth are an Addition of more Ground, or changing it, and are more properly purchaſing than cultivating.

Their

in time become equal: For tho' Ten Plants that produce an Ounce of Wheat, inſume more *Pabulum* than one Plant that produces the ſame Quantity (the Reaſon for which is given in the Note on *p.* 121.); yet a Plant that produces Six or Seven Drams, inſumes leſs than one that produces an Ounce; for a Plant which produces Six Drams of Wheat cannot be a poor one, and therefore inſumes no more *Pabulum* than in proportion to its Augment and Product. Thus the Soil of thoſe Ends, which, by being doubly exhauſted by Weeds and Wheat-plants, was made poorer, gradually recovers an Equality with the other Ends, by being for ſeveral Years leſs exhauſted than the other Ends are by larger Plants, whilſt the Number of Plants, and the Pulveration of each, are equal.

To the Reaſons already given there is another to be added, why Horſe-ho'd Wheat exhauſts the Soil leſs than ſown Crops, where the Product of Wheat produc'd by each is equal: Which Reaſon is, that the former has much leſs Straw than the latter; as appears by the different Quantities of Grain that a Sheaf of each of equal Diameter yields; one of the former yielding generally double to one of the latter; for a Sheaf of the ſown has not only more ſmall Under-ears, but alſo its beſt Ears bear a leſs Proportion to their Straw than the other; for a Straw of ſown Wheat Six Feet high, I have found to have an Ear but of half the Size of an Ear of drill'd Wheat on a Stalk Five Feet high, having meaſured both of them ſtanding in the Field, and rubb'd out the Grain of them. This Difference I impute to the different Supply of Nouriſhment at the time when the Ears are forming.

Thus the ſown Crop exhauſts a Soil much more by its greater Quantity of Straw.

And this is one Reaſon why annual Crops of ſown Wheat cannot ſucceed as Crops of Horſe-ho'd Wheat do. There muſt be Dung and Fallow to repair the Exhauſtion of the ſown; neither of which are neceſſary for Crops of the Horſe-ho'd.

(*a*) It may be aſked, How 'tis poſſible that Eight Hoeings, which are but equal, in Labour, to Two plain Plowings, ſhould ſo much exceed Three plain Plowings, as to procure as good or a better Crop without Manure, than the common Three Plowings can do with Manure, and enrich the Land alſo.

The Anſwer is, That each Hoeing of the Five or Six being done to the Wheat-plants, though it does not clean plow the whole Interval underneath, yet it changeth the whole external Superficies (or Surface) thereof, whereby it becomes impregnate

by

Their One Year's Tillage, which is but Two Plowings before Seed-time, commonly makes but little Duſt; and that which it does make, has but a ſhort time to lie expoſed for Impregnation; and after the Wheat is ſown, the Land lies unmoved for near Twelve Months, all the while gradually loſing its Paſture, by ſubſiding, and by being continually exhauſted in feeding a treble Stock of Wheat-plants, and a Stock of Weeds, which are ſometimes a greater Stock. This puts the Advocates for the old Method upon a Neceſſity of uſing of Dung, which is, at beſt, but a Succedaneum *of the Hoe; for it depends chiefly on the Weather, and other Accidents, whether it may prove ſufficient by Fermentation to pulverize in the Spring, or no: And it is a Queſtion whether it will equal Two additional (a) Hoeings, or but one; tho', as I have computed it, one Dunging coſts the Price of One hundred Hoeings.*

When they have done all they can, the Paſture they raiſe, is generally too little for the Stock that is to be maintain'd upon it, and much the greateſt Part of the Wheat plants are ſtarved; for from Twenty Gallons of Seed they ſow on an Acre, they receive commonly no more than Twenty Buſhels *(b)* of Wheat in their Crop, which is but an Increaſe of Eight Grains for one: Now, conſidering how many Grains there are in one good Ear, and how many Ears

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by the nitrous Air, as much as if it were all clean plowed at the time of every Hoeing, and the Weeds are as much ſtifled, or ſuffocated.

(*a*) Additional, becauſe there muſt firſt be ſeveral Hoeings to make our treble Row equal to an undunged Six-feet Ridge of ſown Wheat.

(*b*) And they have oftener leſs than Sixteen Buſhels; and in the Harveſt 1735. a ſubſtantial experienced Farmer had no more than Four Buſhels of Wheat to an Acre throughout a Field of Forty Acres, being robbed by Poppies; and I have known a Crop that has amounted to no more than Two Buſhels to an Acre, and ſome Crops leſs, tho' dunged and fallowed; ſo that, taking the common ſown Crops of Wheat one with another, they are thought not to amount to Sixteen Buſhels to an Acre, *communibus annis.*

on one Plant, we find, that there is not One Plant in Ten that lives till Harveſt, even when there has not been Froſt in the Winter ſufficient to kill any of them; or if we count the Number of Plants that come up on a certain Meaſure of Ground, and count them again in the Spring, and likewiſe at Harveſt, we ſhall be ſatisfied, that moſt or all of the Plants that are miſſing, could die by no other Accident than want of Nouriſhment.

They are obliged to ſow this great Quantity of Seed, to the end that the Wheat, by the great Number of Plants, may be the better able to contend with the Weeds; and yet, too often, at Harveſt, we ſee a great Crop of Weeds, and very little Wheat among them. Therefore this Paſture, being inſufficient to maintain the preſent Crop, without ſtarving the greateſt Part of its Plants, is likely to be leſs able to maintain a ſubſequent Crop, than that Paſture which is not ſo much exhauſted.

When their Crop of Wheat is much leſs than ours, their Vacancies, if computed all together, may be greater than thoſe of our Partitions and Intervals; theirs, by being irregular, ſerve chiefly for the Protection of Weeds; for they cannot be plow'd out, without deſtroying the Corn, any more than Cannons firing at a Breach, whereon both Sides are contending, can kill Enemies, and not Friends.

Their Plants ſtand on the Ground in a confuſed manner, like a Rabble; ours like a diſciplin'd Army: We make the moſt of our Ground; for we can, if we pleaſe, cleanſe the Partitions with a Hand-hoe *(b)*; and for the reſt, if the Soil be deep enough to be drill'd on the Level *(c)*, in treble Rows, the Par-

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(*b*) Of all annual Weeds.

(*c*) This is only put as a Suppoſition; for I have for theſe ſeveral Years left off drilling on the Level, and do adviſe againſt it; becauſe altho' Mould ſhould not be wanting for the Partitions in deep rich Land, yet it is much more difficult to hoe on the Level than on Ridges.

titions at Six Inches *(d)*, the Intervals Five Feet; Five Parts in Six of the whole Field may be pulveriz'd every Year, and at proper times all round the Year.

The Partitions being one Sixth-part for the Crop to ſtand on, and to be nouriſhed in the Winter, one other Sixth-part being well pulveriz'd, may be ſufficient to nouriſh it from thence till Harveſt *(e)*; the Remainder, being Two-thirds of the Whole, may be kept unexhauſted, the One-third for one Year, and the other Third of it Two Years; all kept open for the Reception of the Benefits deſcending from above, during ſo long a time; whilſt the ſowed Land is ſhut againſt them every Summer, except the little time in which it is fallow'd, once in Three Years, and a little, perhaps, whilſt they plow it for Barley in the Winter, which is a Seaſon ſeldom proper for pulverizing the Ground.

Their Land muſt have been exhauſted as well by thoſe ſupernumerary Plants of Wheat, while they lived, as by thoſe that remain for the Crop, and by the Weeds. Our Land muſt be much leſs exhauſted, when it has never above one Third-part of the Wheat-plants to nouriſh that they have, and generally no Weeds; ſo that our ho'd Land having much more vegetable Paſture made, and continually renewed, to ſo much a leſs Stock of Plants *(f)*, muſt needs be

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(*d*) But when it is drilled upon Ridges, the Proportion is leſs, by how much the Partitions, being thicker in Mould, contain more than a Sixth-part of the whole Six Feet of Earth, and the Proportion of unexhauſted Earth will be alter'd likewiſe; and I only mention theſe Diſtances to avoid Fractions.

(*e*) This may be done, tho' the Roots of a competent Number of Plants run through the Whole, in the manner herein before explained.

(f) Therefore, whenever a Soil receives more Supplies of fine Earth from the Atmoſphere, than is exhauſted by all the Plants that grow in the Soil, it becomes richer; but if the contrary, then it becomes poorer.

left, by every Crop, in a much better Condition than theirs is left in by any one of their ſown Crops, altho' our Crops of Corn at Harveſt be better than theirs *(g)*.

They object againſt us, ſaying, That ſometimes the Hoeing makes Wheat too ſtrong and groſs, whereby it becomes the more liable to the Blacks (or Blight of Inſects): But this is the Fault of the Hoer; for he may chooſe whether he will make it too ſtrong, becauſe he may apply his Hoeings at proper times only, and apportion the Nouriſhment to the Number and Bulk of his Plants. However, by this Objection they allow, that the Hoe can give Nouriſhment enough, and therefore they cannot maintain, that there is a Neceſſity of Dung *(h)* in the Hoeing-Huſbandry; and

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(*g*) On an undung'd low Six-feet Ridge, we have Three Rows, Eight Inches aſunder, all which being equal, during the Winter, but each of the Two outſide Rows at Harveſt producing Ten times as much Wheat as the middle Row doth, all Three together produce a Quantity equal to One-and-twenty of this middle Row. Now, ſuppoſing the Roots of this Row not to reach through the outſide Rows, ſo as to receive any Benefit from the ho'd Intervals, then this Row might only be equal to one of Nine Rows, which ſhould have been drilled Eight Inches aſunder on this Ridge, and then our Three would only be equal to Twenty-one of ſuch Nine Rows. But ſince it can be demonſtrated, that the Roots of our middle Row do paſs through both the outſide Rows far into the ho'd Intervals, we may well ſuppoſe it to be at leaſt double to what it would have been, if it had no Benefit from the Hoeing, and then our Three will be equal to Forty-two of ſuch Nine unho'd Rows. Thus our Crop is Thirty-three in Forty-two (or almoſt Four Parts in Five) increaſed by the Hoeing; for though many Fields of Wheat have been drilled all over in Rows Eight Inches aſunder, it never has been judged in Twenty Years Experience, that a Crop ſo planted, though not ho'd, was, by its Evenneſs and Regularity, leſs, *cæteris paribus*, than a Crop ſown at random.

(*h*) As for the Quantity of vegetable Matter of Dung, when reduced to Earth by Putrefaction, it is very inconſiderable, and, of many ſorts of Manure, next to nothing.

The almoſt only Uſe of all Manure is the ſame as of Tillage; *viz.* the Pulveration it makes by Fermentation, as Tillage doth by and that, if our Crops of Wheat ſhould happen to ſuffer, by being too ſtrong, our Loſs will be leſs than theirs, when that is too ſtrong, ſince it will coſt them Nine times our Expence to make it ſo.

A Second Objection is, That as Hoeing makes poor Land become rich enough to bear good Crops of Wheat for ſeveral Years ſucceſſively, the ſame muſt needs make very good Land become too rich for Wheat. I anſwer, That if poſſibly it ſhould ſo happen, there are Two Remedies to be uſed in ſuch a Caſe; the one is to plant it with Beans, or ſome other Vegetables, which cannot be over-nouriſhed, as Turneps, Carrots, Cabbages, and ſuch-like, which are excellent Food for fatting of Cattle; or elſe they may make uſe of the other infallible Remedy, when that rich Land, by producing Crops every Year in the Hoeing-Huſbandry, is grown too vigorous and reſty, they may ſoon take down its Mettle, by ſowing it a few Years in their old Huſbandry, which will fill it again with a new Stock of Weeds, that will ſuck it out of Heart, and exhauſt more of its Vigour, than the Dung *(i)*, that helps to produce them, can reſtore.

There is a Third Objection, and that is, That the Benefit of ſome Ground is loſt where the Hoe-plough turns at each End of the Lands: But this cannot be much, if any, Damage; becauſe about Four-ſquare

by Attrition or Contuſion; and with theſe Differences, that Dung, which is the moſt common Manure, is apt to increaſe Weeds, as Tillage (of which Hoeing is chief) deſtroys them, and Manure is ſcanty in moſt Places, but Tillage may be had every-where. Another Difference is, the vaſt Diſproportion of the Price of Manure, and that of Tillage.

Note, As we have no way to enrich the Soil, but by Pulveration of Manure, or of Inſtruments, or of both; ſo Nature has ordain'd, that the Soil ſhall be exhauſted by nothing, but by the Roots of Plants.

(i) Dung made of the Straw of ſown Corn generally abounds with the Seed of Weeds.

Perch to a Statute Acre is ſufficient for this Purpoſe; and that, at the Rate of *Ten Shillings* Rent, comes to but *Three-pence*, tho' this varies, according as the Piece is longer or ſhorter; and ſuppoſing the moſt to be Eight Perch, that is but *Six-pence per* Acre; and that is not loſt neither; for whether it be of natural or artificial Graſs, the Hoe-plough, in turning on it, will ſcratch it, and leave ſome Earth on it, which will enrich it ſo much, that it may be worth its Rent for Baiting of Horſes or Oxen upon it. And beſides, theſe Ends are commonly near Quick-hedges or Trees, which do ſo exhauſt it, that when no Cattle come there to manure it, 'tis not worth the Labour of plowing it.

CHAP. XVIII.

Of PLOUGHS.

BY what means Ploughs and Tillage itſelf came at firſt to be invented, is uncertain; therefore we are at Liberty to gueſs: And it ſeems moſt probable, that it was, like moſt other Inventions, found out by Accident, and that the firſt Tillers, or Plowers, of the Ground, were Hogs: Men in thoſe Days, having ſufficient Leiſure for Speculation, obſerv'd, that when any ſort of Seed happen'd to fall on a Spot of Ground well routed up by the Swine (which Inſtinct had inſtructed to dig in Search of their Food), it grew and proſpered much better than in the whole unbroken Turf. This Obſervation muſt naturally induce rational Creatures to the Contrivance of ſome Inſtrument, which might imitate, if not excel Brutes in this Operation of breaking and dividing the Surface of the Earth, in order to increaſe and better its Product.

That ſome ſuch Accident gave Men the Firſt Hints of *original Agriculture*, may be inferr'd from the very little (or no) Probability of its being invented originally upon Arguments which might convince the Underſtanding (by juſt Concluſions from Ideas of the Earth and Vegetation) of any reaſonable Grounds to hope, that the Effect of increaſing the Earth's Produce ſhould follow the Cauſe of Tillage; or, in other Words, why it ſhould produce more when tilled, than when untilled. Therefore it is very unlikely, that Men ſhould begin to take Pains to till the Land without any ſort of Reaſon why they did it. And no ſuch Reaſon could they have before the Invention, as they had afterwards: For when they accidentally ſaw that Effect follow that Cauſe, then they were well convinced it did ſo. But tho' this Argument, *viz.* Tillage increaſes the Product of the Earth, becauſe it does, has been ſufficient to continue the Practice of Tillage ever ſince; yet it is impoſſible for the Inventors to have had this Argument before the Invention, in caſe it had been invented by Men, and not fortuitouſly diſcover'd.

Had there ever been extant any other or better Arguments, whereon this Practice, ſo uſeful to Mankind, was founded; ſure, ſome of all the great and learned Authors, who have written on this Subject, would have mention'd them. Philoſophers, Orators, and Poets, have treated of it in the ſame Theory by which it was firſt diſcover'd, and by no other; *viz.* Land produces more when tilled; and ſome ſeem to ſay, the more it is tilled, the more it produces. It does, becauſe it does; not a Word of the Paſture of Plants, or any thing like it. So that all the antient *Scriptores de re ruſticâ* have done, was only to keep that Theory in the ſame Degree of Perfection in which the firſt Diſcoverers received it.

The briſtled Animals broke up the Ground, becauſe they uſed to find their Food there by digging;

Men till it, becauſe they find Tillage procures them better Food than Acorns.

The Reaſons are the ſame for one and the other.

Theſe Writers, aſham'd to acknowlege ſo noble a Diſcovery to be owing to ſo mean a Foundation, make no mention of the true Teachers, but attribute the Invention to *Ceres*, a Goddeſs of their own makeing; ſhe, as they pretend, firſt taught the Art of Tillage. With this Fable they were ſo well pleaſed, that they never attempted to improve that Art, leſt they ſhould derogate from the Divinity of *Ceres*, in ſuppoſing her Invention imperfect.

With what Inſtrument Men firſt tilled the Ground, we don't know exactly; but there may be Reaſons to believe it was with the Spade, and probably a wooden one, and very rough.

For whilſt People liv'd on Acorns, there was no Uſe of the Smith; ſuch Food required no Knives for eating it, nor was it worth while to make Swords to fight for it; and without Iron the Spade could not be well hewn, or ſhap'd; but if it had been ſuch as it is at preſent, there never was any thing comparable to it, for the true Uſe of Tillage. Yet the Spade could not make that Expedition, which was neceſſary when Tillage became general in the Fields; and therefore in time the Spade came wholly to be appropriate to the moſt perfect Sort of Tillage in the Garden. Then the Plough ſupply'd the Place of the Spade in the Field; and tho' it could not (ſuch as it was) till the Land near ſo well, yet it could till Ten times more of it, and with leſs human Labour.

Why they did not improve the Plough, ſo that it might alſo till as well as the Spade, ſeems owing to their Primitive Theory, which gave no Mathematical Reaſon to ſhew wherein the true Method of Tillage did conſiſt; *viz.* in dividing the Earth into many Parts, to increaſe its internal Superficies, which is the Paſture of Plants.

The Difference betwixt the Operation of the Spade, and that of the common Plough, is only this; that the former commonly divides the Soil into ſmaller Pieces, and goes deeper.

How eaſy and natural it is to contrive a Plough that may equal the Spade, if not exceed it, in going deeper, and cutting the Soil into ſmaller Pieces, than the Spade commonly does, I leave to the Judgment of thoſe who have ſeen the Four-coulter'd Plough.

The Plough deſcrib'd by *Virgil* had no Coulter; neither do I remember to have ſeen any Coulter in *Italy*, or the South of *France*; and, as I have been informed, the Ploughs in *Greece*, and all the *Eaſt*, are of much the ſame Faſhion: Neither is it practicable to uſe a Coulter in ſuch a Plough; becauſe the Share does not cut the Bottom of the Furrow horizontally, but obliquely; in going one way, it turns off the Furrow to the right Hand; but in coming back, it turns it to the Left (*a*). Therefore, if it had a Coulter, it muſt have been on the wrong Side every other Furrow: And beſides, as the Handle (for it has but one) always holds the Plough towards one Side, with the Bottom of the Share towards the unplow'd Land, it would cauſe the Coulter to go much too low when it went on the Furrow-ſide, and it would not touch the Ground, when it went on the Land-ſide.

'Tis a great Miſtake in thoſe who ſay *Virgil*'s Plough had Two Earth-boards; for it had none at all; but the Share itſelf always going obliquely, ſerved inſtead of an Earth-board; and the Two Ears, which were the Corners of a Piece of Wood lying under

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(*a*) *Note*, This *Eaſtern* Plough always goes forward, and returns back in the ſame Furrow, making only one Land of a whole Field: Though it turns its one Furrow towards the Right, and the other towards the Left of the Holder; yet every Furrow is turned towards the ſame Point of the Compaſs, as when we plow with a Turn-wriſt Plough.

the Share, did the Office of Ground-wreſts: This Faſhion continues to this Day in thoſe Countries, and in *Languedoc*.

This ſort of Plough performs tolerably when Ground is fine, and makes a ſhift to break up light Land; and I could never find any other Land there; I am ſure none comparable to ours for Strength: And it would be next to impoſſible, to break up ſuch as we in *England* call ſtrong Land with it.

I do not find, that the Arable Lands about *Rome* are ever ſuffered to lie ſtill long enough to come to a Turf; but I have obſerv'd in the low rich Lands in the *Calabria*'s, ſubject to the Invaſions of the *Turks*, that there is Turf, and that theſe Ploughs go over the Land Two or Three times before the Turf of it is all broken, tho' the Soil be a very mellow Sort of Garden-mould. Having no Coulters to cut it, they break and tear the Turf into little Pieces. This was done in the Month of *November*; and had I not ſeen Men and Oxen at the Work, or had there been Oaks in the Place, I ſhould rather have thought that Tillage perform'd by a Race of the firſt Teachers of it, in muzzling Acorns, than by Ploughs. However, the Mould being naturally very mellow, when the Turf is broken with ſhallow Plowing, they can plow deeper afterwards.

The *Engliſh* Ploughs are very different from the *Eaſtern*, as in general the Soil is.

Theſe, when well made, cut off the Furrow at the Bottom horizontally; and therefore, it being as thick on the Land-ſide, as on the Furrow-ſide, the Plough cannot break it off from the whole Land, at ſuch a Thickneſs (being Six times greater than the *Eaſtern* Ploughs have to break off), and muſt of Neceſſity have a Coulter to cut it off: By this means the Furrow is turn'd perfectly whole, and no Part of the Turf of it broken; and if it lie long without new turning, the Graſs from the Edges will ſpread, and form a new Turf (or Swérd) on the other Side, which was the Bottom of the Furrow before turning, but is now become the Surface of the Earth, and may ſoon become greener with Graſs than before Plowing; and often the very Roots ſend up new Heads to help ſtock the reverſed Furrow, the former Heads being converted into Roots, ſo that it is doubly cloathed and braced on both Sides, or, as it were, kay'd together, firm and ſolid, almoſt as a Plank; it may be drawn from one Side of a Field to the other without breaking, and might poſſibly be made uſe of, inſtead of *Virgil*'s *Crates Viminea*; for harrowing or ſmoothing of fine-till'd Ground; but not without much Time, Labour, and Difficulty, can it be made ſuch itſelf.

If you plow whole ſtrong turfy Furrows croſs-ways, as *Virgil* directs, and as it is too commonly practiſed, the Coulter cannot eaſily cut them, becauſe, being looſe underneath, they do not make a ſufficient Reſiſtance or Preſſure againſt its Edge, but move before it, and ſo are apt to be drawn and driven up into Heaps, with their Surfaces lying all manner of Ways, and ſituate in all manner of Poſtures: So the Turf, which is not turned, continuing in the open Air, grows on, and with its vigorous Roots holds the Earth faſt together, and will not ſuffer the neceſſary Diviſion to be made, which would be, if the Turf were rotten, and which is the End of all Tillage, *viz.* to increaſe the Paſture of Plants.

Next, ſome have vaſt heavy Drags, with great long Iron Tines in them; and tho' theſe huge broken Pieces of Furrows, being looſer than before, require keener Edges to cut them; yet theſe Drag-tines have no Edge at all, but are as blunt as the Furrows they ſhould cut. Theſe Drags draw them ſometimes into larger Heaps, leaving the under *Stratum* bare betwixt them, only ſhaking off ſome of their Mould in tumbling them about, and ſcratching their Surfaces, without reducing them to a moderate Fineneſs, until this ill-broken Land has, for above a Year, and ſometimes longer, entertained Ploughs, Cattle, and Men, with a frequent laborious Exerciſe, for which they are obliged to the one Coulter.

If the Soil be ſhallow, it may be broken up with a narrow Furrow, which will the ſooner be brought in Tilth; but if it be a deep Soil, the Furrows muſt be proportionably large, or elſe a Part of the good Mould muſt be left under unmoved, and ſo loſt; for a narrow Furrow cannot be plowed deep, becauſe the Plough will continually ſlip out from the hard Land toward the Right-hand, unleſs the riſing Furrow be of ſufficient Weight to preſs the Plough towards the Left, and keep it in its Work: The deeper you plow, the greater Weight is required to preſs it; ſo that the deeper your Land is, the worſe (or into the larger Furrows) muſt it be broken up with one Coulter, inſomuch that, if the Land be ſtrong (as moſt deep Ground in *England* is), it is a Work of ſome Years to conquer it, after it has been reſted. And often it happens, that the exceſſive Charge of this Tillage reduces the Profit of rich Land below that of poor.

This gives an Opportunity to deceitful Servants, of impoſing upon their ignorant Maſters. They plow ſuch deep Land with a ſmall ſhallow Furrow, to the end the Turf and Furrows may be broken, and made fine the ſooner; pretending they will plow it deeper the next time (which is called Stirring), which theſe Rogues know very well cannot be done, and intend no more than that the Plough coming the eaſier after the Horſes, their Coats may ſhine the better; and tho' there be no Crop at Harveſt, they muſt have Four Meals a Day all the Year, and extravagant Wages at *Michaelmas*, or at any time of the Year, when they think fit to miſbehave themſelves.

This ſort of Land muſt not be ſtirred, *i. e.* plowed the Second time in wet Weather; for that will cauſe the Graſs and Weeds to multiply, beſides the treading the Ground into hard Dabs, *&c.* And, in dry Weather, the Plough will never enter any deeper than it went the firſt time; the Reſiſtance below being ſo much more than the Preſſure above, the Plough will riſe up continually; or, if it goes deep enough for the Weight of Earth to keep it down, another Inconvenience will follow, which is that mention'd by *Columella, Page* 47. *Quod omnis humus, quamvis lætiſſima, tamen inferiorem partem jejuniorem habet, eamque attrahunt excitatæ majores glebæ; quo evenit, ut infæcundior materia miſta pinguiori ſegetem minus uberem reddat.* The vulgar *Engliſh* Phraſe is, It ſpaults up from below the Staple. Hence the treacherous Plowman is ſecure of an eaſy Summer's Work, if he can perſuade his Maſter to ſuffer him to fallow the Ground with a ſhallow Furrow.

Another way to conquer a ſtrong Turf is, to plow it firſt with a Breaſt-plough, very thin; and, when the Swerd is rotten, then plow it at the proper Depth: But this Method is (beſides the extraordinary Charge of it) liable to other great Misfortunes. If the Turf be pared up in Winter, or early in the Spring, it is a Chance but the Rains cauſe it to grow ſtronger than before, inſtead of its Rotting.

And if it be pared later, tho' dry Weather do follow, and continue long enough to kill the Turf, yet this loſes time; the Seaſon of Plowing is retarded; for all the Staple ſtill remains untill'd; and, before that can be well done, the Year is too far ſpent for ſowing it with Wheat, which is the moſt proper Grain for ſuch ſtrong Land (*a*); and few will have Patience to wait, and plow on till another Wheat-ſeed

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(*a*) Beſides, moſt ſtrong Land has Stones in it, which will not admit the Uſe of the Breaſt-plough.

time. The dry Weather alſo, which in Summer kills the Swerd, renders the Plowing obnoxious to moſt or all the Evils afore-mention'd.

A Farmer inquires concerning the Four-coulter Plough, as in the following DIALOGUE.

Farm. *What muſt we do then? Muſt we have recourſe to the Spade for breaking up our rich, ſtrong, ſwerdy Land?*

Reſp. If you can procure Men to dig it faithfully in Pieces, not above Two Inches and an half thick, at the Price of about Eight Shillings *per* Acre, it would do very well, and anſwer all the Ends of Tillage; but, tho' you bargain with them to dig it at that Size for Three Pounds *per* Acre, you will find, upon Examination, moſt of the Pieces or Spits, which are dug out of your Sight, to be of twice that Thickneſs. And no great Quantities can be this way managed, altho' the Price of Corn ſhould anſwer ſuch an extravagant Expence.

Farm. *Since it is ſo difficult to bring our ſtrong Land into Tilth, after it has reſted, that it cannot be ſpeedily done by a Plough without a Coulter, or by one with a Coulter, in wet Weather or dry, nor with a Breaſt-plough, without a certain Expence, and an uncertain Succeſs, the Spade is too chargeable a Tillage for the Field: It ſeems to me, upon the Whole, that we are Loſers by this* inaratæ gratia terræ, *unleſs we could contrive ſome other Method of reducing it ſooner, and with leſs Charge, into Tilth; for I obſerve, that, when we ſow it upon the Back, the Corn and Graſs (or Couch), coming both together, exhauſt the Ground ſo much, that by that time we can (which is about Three Years) reduce the great Lumps to a tolerable Fineneſs, it grows full of Graſs and Weeds (which we call Foul), and loſes that Fertility we expected it ſhould acquire by Reſt, becoming,*

coming, in our Terms, both out of Tilth, and out of Heart.

Reſp. If you know all this to be true, and that without a Coulter you cannot break it up at all; and that with one Coulter you cannot any way cut the Furrow ſmall enough, or leſs than Ten Inches broad; why do not you cut it with Four Coulters, which will reduce the ſame Furrow into Four equal Parts, of Two Inches and an half each in Breadth, and of the Depth of the Staple, tho' that ſhould be Two Spit, or Sixteen Inches deep?

Farm. *How can that be done?*

Reſp. Every jot as eaſily as with one Coulter: For, before the Furrow is rais'd by the Share, it lies faſt, and makes a ſufficient Reſiſtance equally againſt the Edges of all the Coulters; tho', after it be rais'd and looſe, it yields and recedes every way, except downwards; ſo that it cannot be cut by any Edge, but ſuch as attacks it perpendicularly from above, as that of the Spade does.

Farm. *This ſeems to me reaſonable; and, having very lately heard talk of this Plough, I would gladly know more of it.*

Reſp. The Furrow, being cut into Four Parts, has not only Four times the Superficies on the Eight Sides which it would have had on Two Sides; but it is alſo more divided croſs-ways; *viz.* The Groundwreſt preſſes and breaks the lower (or Right-hand) Quarter; the other Three Quarters, in riſing and coming over the Earth-board, muſt make a crooked Line about a Fourth longer than the ſtrait one they made before moved; therefore their Thinneſs not being able to hold them together, they are broken into many more Pieces, for want of Tenacity to extend to a longer Line, contrary to a whole Furrow, whoſe great Breadth enables it to ſtretch and extend from a ſhorter to a longer Line, without breaking; and, as it is turn'd off, the Parts are drawn together again by the Spring of the Turf or Sward *(a)*, and ſo remain whole after Plowing. Thus the Four-coulter'd Plow can divide the Soil into above Twenty times more Parts than the common Plough; and ſometimes, when the Earth is of a right Temper betwixt wet and dry, the Earth-board, in turning the Furrows off, will break them into Duſt, having more Superficies than is made by Four common Plowings; and it is impoſſible there ſhould be any large Pieces amongſt it.

Now, what a prodigious Advantage muſt the Influences of the Atmoſphere have upon theſe ſmall Parts, for making a further Diviſion of them! Froſt, Water, Drought, and nitrous Air, eaſily penetrate to their very Centres, which cannot in the largeſt of them be more than one Inch and a Quarter diſtant from their Superficies. This Advantage, with a few ſubſequent common Plowings, perform'd in proper Seaſons, reſolves the Earth almoſt all to a Powder. The Sward, ſome being immers'd or bury'd and mix'd among ſo great a Proportion of Mould, is ſoon rotten and loſt; ſome of the Sward lying looſe a-top, the Earth preſently drops out of it; and then the Roots are dried up, and die. Thus is the whole Staple of the Ground brought into perfect Tilth in

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(*a*) A ſwerdy Furrow cut off by only one Coulter, being whole, is apt to ſtand up on its Edge, or lie hollow; and then, being open to the Air, it does not rot; but when it is cut by ſeveral Coulters, it has not Strength to ſupport itſelf, it falls down, lies cloſe to the Earth under it, and, excluding the free Air from the Turf, it ſoon becomes rotten. And for killing the Turf of ſwerdy Land is the chief Uſe of the Four-coulter'd Plough: For doing of which there is this Advantage, that as in a whole Furrow there are often Strings of Couch-graſs, Three or Four Feet long; but, when cut by this Plough, there is ſcarce a String left of one Foot long: And theſe Strings being apt to ſend out Roots from every Knot or Joint, the ſhorter they are cut, the more they will be expoſed to the Air and Sun, which will kill them the ſooner.

a very ſhort time beyond what the Spade ever does in ſuch ſwerdy Land.

Farm. *What ſort of Weather is beſt for uſing this Plough?*

Reſp. Any Weather, except the Ground be ſo dry and hard, that the Plough cannot enter it; but it is very proper to be done, when the Earth is ſo wet, that by no means it ought to be plowed with any other Plough; for it never can be too moiſt for this, unleſs the Cattle which draw it, be mired; becauſe, tho' all the Cattle ſhould not go in the Furrow, yet their Treadings are cut ſo ſmall by the Coulters, that the Earth is not kept from diſſolving, as when turn'd off whole in common Tillage. 'Tis obſerv'd, that the Inciſions made by the Coulters on ſwerdy Land, will not heal, or ſo cloſe up, but that they will open again by the next Plowing, tho' it be a great while after. A Farmer who uſes this Plough, may till in all Weathers and all Seaſons of the Year, either in fallowing with this, which is beſt in wet, or in ſtirring with the common ones, which muſt be done in dry Weather; and when the Ground is broken up with this, it may be ſtirr'd in the drieſt Weather that can be, without the Danger of tearing (or ſpaulting) up of the under *Stratum* along with the Staple, becauſe this is all broken before, and then no more can riſe with it; as it does to the Ruin of the Soil, when in common Tillage they go deeper the Second time than the Firſt: Alſo, if there be a Neceſſity of ſtirring ſome ſort of Land when it is wet, it ought either to be done with this Plough, or elſe with a common one drawn by a ſingle Row of Cattle treading all in the Furrow; for tho' ſome Land be very fine, yet, when plow'd by a double Row of Cattle in wet Weather, it will be made into large Pieces by the Treading, and perhaps not diſſolve again in a long time: Therefore it is better to be prevented.

Farm. *I perceive this Plough lays the Foundation for all good Huſbandry; and there can be no other way to bring Land into perfect Tilth in ſo ſhort a Time, or with ſo little Expence. And I am convinc'd, that no Farmer ought to be without it, who deſires to be free from the Danger of his Land being ever out of Tilth: But I have heard it objected, that it is harder to draw than the common Ploughs; and that its Beam being longer, upon account of the Four Coulters, it lies farther behind, and comes harder after the Horſes.*

Reſp. I muſt confeſs, there is ſomething in that Objection; for this Plough, being ſomething longer, may be a little the harder Draught; and alſo its Weight and Strength muſt bear a Proportion to the Length of it. But this ſmall Increaſe of the Draught would have been a much ſtronger (if not a fatal) Objection, had that Cuſtom been general, of Horſes drawing by their Tails, as 'tis ſaid to have been formerly in ſome Places; for then, perhaps, a ſufficient Strength of Horſes could not be applied to the Plough. But in Countries where Traces are in Uſe, every Horſe of the Team may draw the Plough equally, and then there will be no other Inconvenience, beſides the adding one Horſe, or keeping a ſtronger Team: And he cannot be wiſe, who would loſe the Profit of his Land, for the Odds of ſometimes adding a Horſe to his Plough. And I am very certain, that this Plough requires a much leſs Strength of Cattle to draw it in moiſt Weather, which is the moſt proper to uſe it in, than to draw a common Plough in the ſame Ground, and at the ſame Depth, in dry Weather; and can ſeldom be uſed ſafely in any other. And the Vulgar, who have always a wrong Cauſe ready at hand to apply to every thing, impute that Draught to the Faſhion of the Plough, which ought to be imputed to its going deeper; and this great Depth at which 'tis capable of plowing, *viz.* Two

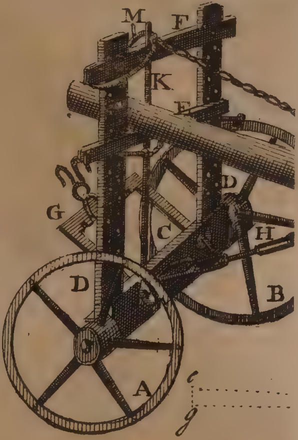
Spit deep, is one extraordinary Benefit of it, tho' it may, on Occaſion, go as ſhallow as any.

The Draught is not ſo much increaſed by adding Three Coulters, as may be imagined; for when the Ground is moiſt, the Inciſions are eaſily made by the Edges; and when they are cut ſmall, the Furrows riſe much more eaſily upon the Share and Earth-Board, than if whole.

Farm. *If this Plough be ſo beneficial, having ſo many Advantages, and only the Two Inconveniencies, one of requiring a little more Strength to draw it, and the other its being unfit for dry hard Ground, I wonder why it is not become more common?*

Reſp. It has been uſed with very great Succeſs for theſe ſeveral Years laſt paſt, but never like to be common, unleſs it be deſcribed in a more geometrical Manner, than any Plough has hitherto been; for the Ploughwrights find it difficult enough to make a common Plough with one Coulter to perform as it ought, for want of the neceſſary Rules of their Art. It is upon this Account that the Two-coulter'd Ploughs are uſed in few Places, though they have been found of excellent Uſe, and have been formerly common: But, alas! when the Makers, who by their diligent Study, and much Practice, had attained the Perfection of their Art, died for want of learning to write their Rules mathematically, and ſhew how the mechanical Powers were applicable to them, the Art was in a manner loſt, at the Death of thoſe Artiſts; and then the unſkilful Ploughwrights, deſtitute of the true Rules, were not able to make a Two-coulter'd Plough to perform well, and then it was left off. Very lately 'tis revived, ſince the Three and Four-coulter'd ones have been uſed; from whence ſome have made a Shift to take the Rules of placing Two Coulters into a Plough, and they begin to be common again; and, no doubt, will ceaſe again as ſoon as the Rules are forgot.

'Tis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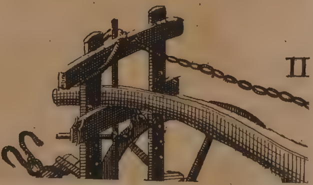
II

Plate. I.

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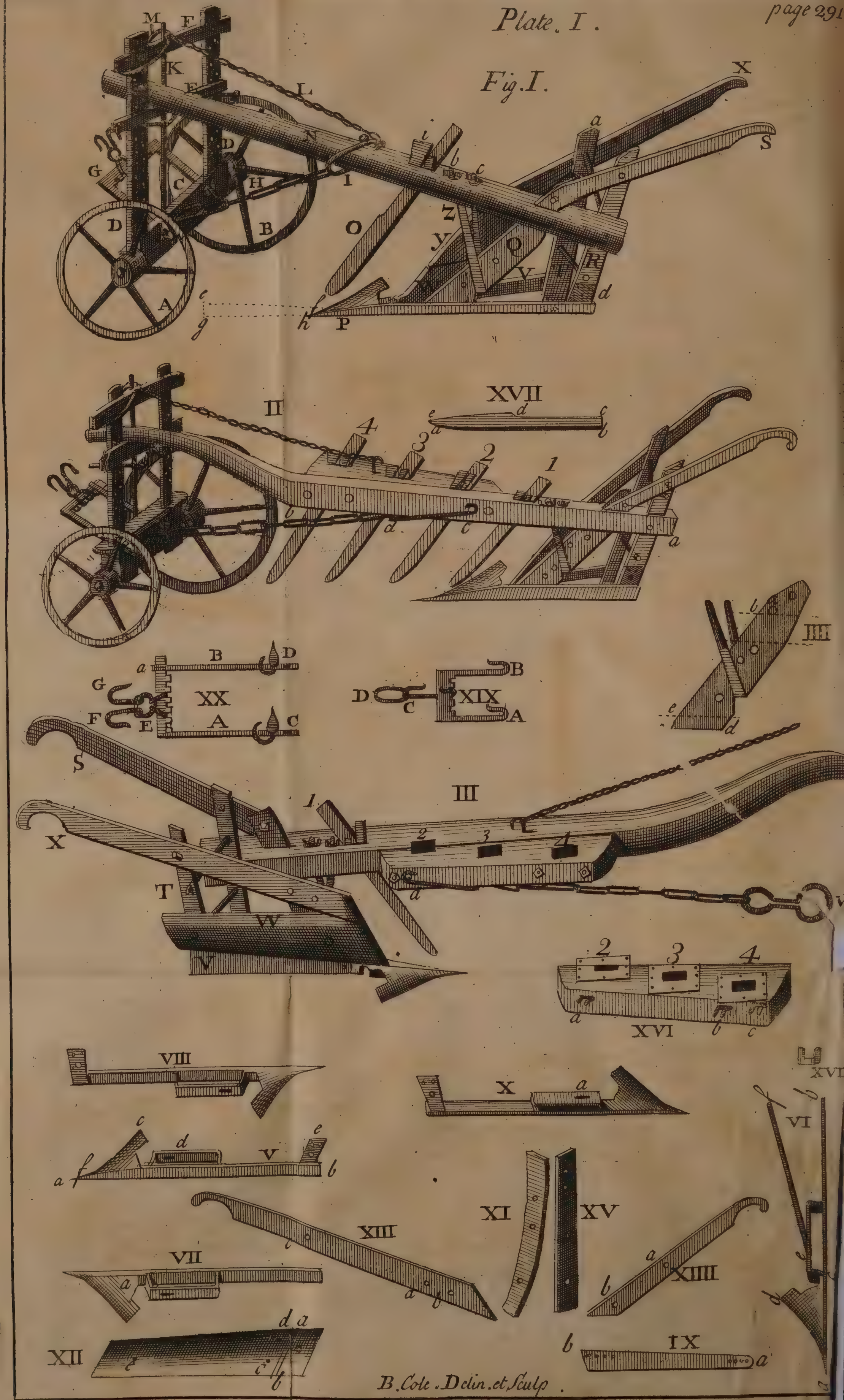

B. Cole. Delin. et Sculp.

'Tis ſtrange that no Author ſhould have written fully of the Fabric of Ploughs! Men of the greateſt Learning have ſpent their Time in contriving Inſtruments to meaſure the immenſe Diſtance of the Stars, and in finding out the Dimenſions, and even Weight, of the Planets: They think it more eligible to ſtudy the Art of plowing the Sea with Ships, than of tilling the Land with Ploughs; they beſtow the utmoſt of their Skill, learnedly, to pervert the natural Uſe of all the Elements for Deſtruction of their own Species, by the bloody Art of War. Some waſte their whole Lives in ſtudying how to arm Death with new Engines of Horror, and inventing an infinite Variety of Slaughter; but think it beneath Men of Learning (who only are capable of doing it) to employ their learned Labours in the Invention of new (or even improving the old) Inſtruments for increaſing of Bread.

The eaſieſt Method of perpetuating the Uſe of the many-coulter'd Ploughs, and other newly-invented Inſtruments of Huſbandry, is by Models, *i. e.* the Things themſelves in little; and theſe may be all portable even in a Man's Pocket: Every Part muſt be fully deſcribed, with the true Dimenſions, and the mathematical Reaſons, on which their Contrivance is founded. Directions alſo for uſing them muſt be given at the ſame time that their Manner of making is deſcribed. In ſome, the very Horſes which draw muſt be repreſented, to ſhew the manner of fixing the Horſes, and the Traces: Cautions againſt all the Errors that may happen by the want of Experience in the Makers or Uſers, muſt be given.

When this is done, and the Rules put into a Method, the new Hoeing-Huſbandry, in all its Branches, will be much more eaſy and certain than the old; becauſe there are no mathematical Rules extant in any Method; and a Man may practiſe the old random Huſbandry all his Life, without attaining ſo much Certainty in Agriculture as may be learned in a few Hours from ſuch a Treatiſe.

The Rules, indeed, require much Labour, Study, and Experience, to compoſe them; but when finiſh'd, will be moſt eaſy to practiſe: Like the Rules for meaſuring Timber; their Uſe is, at firſt Sight, eaſy to every Carpenter, and to moſt Artificers who work in Wood; but no illiterate Perſon is able to compoſe thoſe Rules, or to meaſure Timber without them.

CHAP. XIX.

The Deſcription of a Four-coulter'd Plough.

TO deſcribe all Parts of a Plough geometrically, would require more Time and Learning than I am Maſter of: Therefore leaving that to be done by ſomebody elſe, who is better qualified for it, I ſhall at preſent attempt little more than what relates to the Three added Coulters.

In *Plate* 1. *Fig.* 1. is the Portrait of a common Two-wheel'd Plough uſed in *Berkſhire*, *Hampſhire*, *Oxfordſhire*, and *Wiltſhire*, and in moſt other Counties of *South-Britain*; and is generally eſteemed the beſt Plough for all Sorts of Land, except ſuch miry Clays that ſtick to the Wheels, and clog them up, ſo as they cannot turn round.

But they have, in ſome Places, a Contrivance to prevent this Inconvenience; which is done by winding Thumb-ropes of Straw about the Iron Circles of the Wheels, and about the Spokes. The Wheels preſſing againſt the Ground, the Thumb-ropes are diſtended on each Side: which Motion throws off the Dirt, and prevents its ſticking to the Wheels, which it would otherwiſe do.

'Tis commonly divided into Two Parts; *viz.* the Plough-head, and the Plough-tail.

The Plough-head contains the Two Wheels A, B, and their Axis or Spindle of Iron paſſing thro' the

Box C, turning round both therein, and in the Wheels; the Two Crow-ſtaves D, D, faſtened into the Box perpendicularly, and having in each, Two Rows of Holes, whereby to raiſe or ſink the Beam, by pinning up or down the Pillow E, to increaſe or diminiſh the Depth of the Furrow; the Gallows F, thro' which the Crow-ſtaves paſs at top, by Mortiſes, into which they are pinned; G the Wilds with its Links and Crooks of Iron, whereby the whole Plough is drawn; H the Tow-chain, which faſtens the Plough-tail to the Plough-head, by the Collar I at one End, and by the other End paſſing thro' a Hole in the Middle of the Box, is pinned in by the Stake K; L the Bridle-chain, one End whereof is faſtened to the Beam by a Pin, and the other End to the Top of the Stake, which Stake is held up to the left Crow-ſtaff, by the With M, paſſing round it above, and under the End of the Gallows below; or inſtead of this With, by a Piece of Cord, and ſometimes by the End of the Bridle-chain, when that is long enough.

The Plough-tail conſiſts of the Beam N; the Coulter O; the Share P; and the Sheat Q; the Hinder-ſheat R, paſſing thro' the Beam near its End; S the ſhort Handle, faſtened to the Top of the Hinder-ſheat by a Pin, and to the Top of the Sheat by another Pin; T the Drock which belongs to the right Side of the Plough-tail, and whereto the Ground-wriſt V is faſten'd; as is the Earth-board, whoſe Fore-part W is ſeen before the Sheat; and alſo the long Handle X, whoſe Fore-part Y appears before the Sheat, and is faſten'd to the Drock by a Pin at *a*, the other End of which Pin goes into the Beam. Z is the double Retch, which holds up the Sheat, and paſſes through the Beam to be faſten'd by its Screws and Nuts at *b* and *c*.

But without intrenching much farther upon the common Ploughwright's Art, whoſe Trade is his Living, I'll haſten to ſhew the neceſſary Difference

there

there is betwixt the common Plough, and the Four-coulter Plough, beginning with *Fig.* 2. where it is repreſented as ſtanding upon a level Surface.

Fig. 2. And, Firſt, The Beam differs in Length, being Ten Feet Four Inches long, as the other Plough-beam is but Eight Feet; it differs in Shape as the other is ſtrait from one End to the other, but this is ſtrait only from *a* to *b*, and thence turns up of a ſudden, in the manner that is ſhewn in the Cut; ſo that a Line let down perpendicular, from the Corner at *a*, to the even Surface whereon the Plough ſtands, would be Eleven Inches and an half, which is its Height in that Place; and, if another Line were let down, from the turning of the Beam at *b*, to the ſame Surface, it would be One Foot Eight Inches and an half, which is the Height that the Beam ſtands from the Ground, at that Part; and a Third Line let down to the Surface, from the Bottom of the Beam, at that Part which bears upon the Pillow, will ſhew the Beam to be Two Feet Ten Inches high above the Surface in that Part.

From the End *a*, to the Back-part of the firſt Coulter, is Three Feet Two Inches; from thence, to the Back of the next Coulter, is Thirteen Inches; thence to the Third, Thirteen Inches; and from thence to the Fourth, the ſame. From *a* to *b* is Seven Feet.

This Crookedneſs of the Beam is to avoid the too great Length of the foremoſt Coulters, which would be neceſſary if the Beam was ſtrait; and then, unleſs they were vaſtly thick and heavy, they would be apt to bend, and the Point of the Fourth would be at ſo great a Diſtance from its Coulter-hole, that it would have the greater Power to looſen the Wedges, whereby the Coulter would riſe up out of its Work, as it never doth when the Beam is made in this bending Manner. This Beam is made either of Aſh, which is the lighteſt, or of Oak, which is the moſt durable. Its Depth and Breadth may vary, according to the heavier or lighter Soil it is to till; but this before us is in Depth Five Inches at the firſt Coulter-hole, and in Breadth Four Inches.

Fig. 4. Is the Sheat Q in *Fig.* 1. (broad Seven Inches) with the Iron Retch on it, the left Leg of which Retch muſt ſtand foremoſt, to the end that the Edge of its Fore-part, that is flat, may ſit cloſe to the Wood of the Sheat: This Retch holds the Sheat faſt up to the Beam by its Nuts and Screws; as alſo doth a Pin driven into the Hole *a*, which Hole being a ſmall Part of it within the Beam, the Pin being driven into the Hole, draws up the Sheat very tight to the Beam. The Principal thing to be taken notice of here, is the Angle *b c d*, which ſhews the Elevation of the Sheat; the Line *c d* is ſuppoſed to be equal with the Bottom of the Share (or rather with the plain Surface whereon it ſtands); when this Angle at *c* is larger than of Forty-five degrees, a common Plough never goes well: In my Four-coulter Plough I chooſe to have it of Forty-two or Forty-three at the moſt.

Fig. 5. Is the Share; *a* is the End of the Point; *b* is the Tail of the Share, long from *a* to *b* Three Feet Nine Inches; *c* the Fin; *d* the Socket, into which the Bottom of the Sheat enters; *e* a thin Plate of Iron riveted to the Tail of the Share: By this Plate, the Tail of the Share is held to the hinder Sheat, as at *d* in *Fig.* 1. by a ſmall Iron Pin with a Screw at its End, and a Nut ſcrew'd on it on the inner or right Side of that Sheat. From *a* to *f* is the Point, long about Three Inches and an half, flat underneath, and round at Top: It ſhould be of hard Steel underneath. From *f* to *c* is the Edge of the Fin, which ſhould be well ſteeled; the Length of it is uncertain, but it ſhould never make a leſs Angle at *f* than it appears to make in this *Fig.* The Socket is a Mortiſe of about a Foot long, at the upper Part, Two Inches deep: The Fore-end of this Mortiſe muſt not be perpendicular, but oblique, conformable to the Fore-part of the Sheat which enters it; the upper Edge of which Fore-part muſt always bear againſt the Sheat at *e* in *Fig.* 4. but if this End of the Socket ſhould not be quite ſo oblique as the Sheat, it may be help'd, by taking off a little of the Wood at the Point *c*.

Fig. 6. Shews the Share, with its right Side upwards, in the ſame Poſture as when it plows; whoſe Side *a b* ſhould be perfectly ſtrait, but its under Side at *c*, which is its Neck, ſhould be a little hollow from the Ground, but never more than half an Inch in any Plough, and a quarter of an Inch in a Four-coulter Plough; ſo that the Share, when it is firſt made, ſtanding upon its Bottom, bears upon the level Surface only in Three Places; *viz.* at the very Point *a*, at the Tail *b*, and at the Corner of the Fin *d*.

Fig. 7. Is the Share, turn'd Bottom upwards; and ſhews the Concavity of the Fin at *a*; which muſt be greateſt in a ſtony rubbly Soil.

Fig. 8. Shews the Share, the right Side upwards, but leaning towards the Left.

In placing of the Share rightly upon the Sheat, conſiſts the well going of a Plough, and is the moſt difficult Part of a Ploughwright's Trade, and is very difficult to be ſhewn. Suppoſing the Axis of the ſtrait Beam, and the left Side of the Share, to be both horizontal, they muſt never be parallel to each other; for if they were, the Tail of the Share, bearing againſt the Side of the Trench, as much as the Point, would cauſe the Point to incline to the right Hand, and go out of the Ground into the Furrow. If the Point of the Share ſhould be ſet, ſo that its Side ſhould make an Angle on the right Side of the Axis of the Beam, this Inconvenience would be much greater; and if its Point ſhould incline much to the

Left, and make too large an Angle on that Side with the Axis of the Beam, the Plough would run quite to the left Hand; and if the Holder, to prevent its running out of the Ground, turns the upper Part of his Plough towards the left Hand, the Fin of the Share will riſe up, and cut the Furrow diagonally *(a)*, leaving it half unplow'd; beſide, the Plough will riſe up at the Tail, and go all upon the Point of the Share: To avoid theſe Inconveniences, the ſtrait Side of the Share muſt make an Angle on the left Side of the Beam, but ſo very acute, that the Tail of the Share may only preſs leſs againſt the Side of the Trench than the Point does. This Angle is ſhewn by the prick'd Lines at the Bottom of *Fig.* 1. where the prick'd Line *e f* is ſuppoſed to be

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(*a*) This is the greateſt Misfortune incident to a common Two-wheeled Plough, and happens generally by the Fault of the Maker, though ſometimes by the Plowman's ſetting it ſo, that the Point of the Share turns too much to the Left. I have ſeen Land plow'd in this manner, where not half of it has been moved, nor better tilled than by Raftering, not only cut diagonally, but alſo half the Surface hath remained whole, where when the Earth that was thrown on it was removed, the Weeds appeared unhurt on the unplow'd Surface. In this Caſe, they for a Remedy ſet the Plough to go deeper; and then, if it go deep enough for the Fin to cut off the Furrow at a juſt Depth, the Point will go below the Staple, which may ruin the Soil, unleſs it be very deep.

When our *Engliſh* Ploughs go in this manner, they make much worſe Work than the *Eaſtern* Ploughs, that have no Coulter; for theſe, contrary to ours, though they always cut their Furrow diagonally, cut it thin on that Side from which it is turned, as our bad Ploughs leave it thin on that Side towards which it is turned. The Earth the *Eaſterns* leave by their Diagonal in one Furrow, is taken off by the next; but ours leaving Part of their Furrow behind them, on the Side next to the plow'd Part of the Field, come at it no more; but the other can plow cleaner, their Diagonal being contrary to ours, which leaves the Trench deepeſt on the Side next to the unplow'd Part of the Field; but unleſs the Fin of the Four-coulter'd Plough go parallel to the Surface of the Earth, it will not plow at all; or will leave Two or Three of its Four Furrows untouched.

the Axis of the Beam let down to the Surface, and the prick'd Line *g f* parallel to the left Side of the Share; but this Angle will vary as thoſe Two prick'd Lines are produc'd forwards to the Fore-end of a long and a ſhort Beam, keeping the ſame Subtenſe: For Ploughwrights always take this Subtenſe at the Fore-end of a Beam, whether it be a long Beam or ſhort one; and it is the Subtenſe *e g*, that determines the Inclination the Point of the Share muſt have toward the left Hand. Ploughwrights differ much in this Matter; but, by what I can learn by thoſe that make the Ploughs I ſee perform the beſt, this Subtenſe at the Fore-end of an Eight-feet Beam ſhould never be more than one Inch and an half; and by full Experience I find, that whether the Beam be long or ſhort, the Subtenſe muſt be the ſame; for when my Ploughwrights take this Subtenſe at Eight Feet from the Tail, when they make my Four-coulter Plough, whoſe Beam is Ten Feet Four Inches long, the Point of the Share will incline too much to the Left, and it will not go well until this Fault be mended, by taking the ſame Subtenſe quite at the End of the Beam; which makes the mentioned Angle more acute.

Fig. 3. Shews the right-hand Side, and upper Side of the Four-coulter Plough, of which V the Iron Ground-wriſt is ſhewn in *Fig.* 9. long Two Feet Five Inches, deep at the End *b* Four Inches, and Three-eighths of an Inch thick, except at the End *a*, where it is thin enough to bend, ſo as to fit cloſe to the Share, as at *e*, in *Fig.* 6. The Ground-wriſt has Four ſmall Holes near its End *a*, into one of which goes a Nail, to faſten it to the Sheat, thro' the long Hole in the Side of the Socket of the Share, as at *a*, in *Fig.* 10. and then it will ſtand in the Poſture ſhewn by *e f*, in *Fig.* 6. From the Outſide of the Ground-wriſt at *f*, to the Outſide of the Share at *b*, is Eleven Inches and an half, which is the Width of the lower Part of the Plough-tail at the Ground; the Ground-wriſt has ſeveral Holes at the upper Side of its broadeſt End, as at *b*, in *Fig.* 9. by which it is nailed to the lower Part of the Drock T, as in *Fig.* 3. which Drock with its Perforations is ſhewn in *Fig.* 11.

Fig. 12. Is the Earth-board, with its Inſide upwards; the Notch *a b* ſhews the Riſing of the Wood, which takes hold of the Edge of the Sheat, to hold it the firmer, to which it is faſtened by the Holes *c* and *d*; and at the other End it is faſtened to the Drock, at the Hole *e*. All which is ſeen as it ſtands mark'd with W, in *Fig.* 3. But this Pin, with which it is faſtened to the Drock, is bigger in the Middle than at each End; which prevents the Earth-board from coming near the Drock: By this Pin, the Earth-board is ſet at a greater or leſs Diſtance from the Drock, as there is Occaſion to throw off the Furrow farther from the Plough at ſome times than at others: It always ſtands conſiderably farther out on the right Hand than the Ground-wriſt does, which is one Reaſon that the Drock is made crooked, bending outwards in that Part.

The long Handle X is *Fig.* 13. long Five Feet Four Inches, broad in the wideſt Part Four Inches, pinned to the Sheat thro' the Holes *a b*, and pinned to the Drock thro' the Hole *c*.

The ſhort Handle S is *Fig.* 14. and is long Three Feet Nine Inches, pinned to the hinder Sheat (being *Fig.* 15.) by the Hole *a*, and to the Top of the Fore-ſheat above the Beam by the Hole *b*.

The Handles are made ſo long, for the more eaſy guiding of the Plough; but the lazy Ploughman is apt to cut them off ſhorter, cloſe up to the Plough, to the end that, bearing his whole Weight thereon, he may in a manner ride inſtead of walking; but if he ſhould thus ride on long Handles, he would tilt up the Fore-end of the Beam, and raiſe the Share out of the Ground.

The chief, and moſt indiſpenſably neceſſary thing to be obſerved, is, to place the Four Coulters in ſuch a manner, that the Four imaginary Planes deſcribed by the Edges of the Four Coulters, as the Plough moves forwards, be all of them parallel to each other, or very nearly ſo; for if any one of them ſhould be much inclin'd to, or recede from, either of the other three, they could not enter the Ground together. In order to place them thus, the Coulter-holes muſt be made thro' the Beam, in the manner as they are ſhewn in *Fig.* 3. *viz.* the Second Coulter-hole is Two Inches and an half more on the Right than the Firſt, the Third, Two and an half more on the right Hand than the Second, and the Fourth, Two Inches and an half more on the right Hand than the Third, conformable to the Four Inciſions or Cuts they are to make in a Ten-inch Furrow: And becauſe no ſingle Beam is broad enough to hold the Four Coulter-holes at this Diſtance, we are forced to add the Piece ſhewn in *Fig.* 16. The Second Hole is made Part in the Beam, and Part in this Piece; the Third and Fourth are made wholly in this Piece, in which *a*, *b*, *c*, are the Ends of the Three Screws, which faſten the Piece to the right Side of the Beam, by their Nuts.

The Diſtance of Two Inches and an half, by which each of the Three added Coulters ſtands more to the right Hand than that immediately behind it, muſt be reckon'd from the Middle of one Hole to the Middle of the other.

The Fore-part of every Hole muſt incline a little towards the Left; ſo that the Backs of the Coulters may not bear againſt the left Side of the Inciſions made by the Edges.

Each Hole, being a Mortiſe, is one Inch and a quarter wide, with its Two oppoſite Sides parallel from Top to Bottom; each of theſe Mortiſes, or Holes, are long at Top Three Inches and an half, and at Bottom Three Inches; the Back-part, or Hinder-end, of each Coulter-hole is not perpendicular, but oblique, and determines the Obliquity of the Standing of the Coulter, which is wedged tight up to it by the Poll-wedge *i*, *Fig.* 1. as all Coulters are.

Fig. 17. Is a Coulter; *a b* is its Length, being Two Feet Eight Inches, before it is worn; *e d* is its Edge, Sixteen Inches long; *d c* is the Length of its Handle, Sixteen Inches; this is made thus long, at firſt, to ſtand above the Plough, that it may be driven down lower, according as the Point wears ſhorter; this Handle is One Inch and Seven Eighths broad, and Seven Eighths of an Inch thick, equally thro' its whole Length: Its Breadth and Thickneſs might be deſcribed by a rectangled Parallelogram.

In all Ploughs this firſt Coulter is, or ought to be, plac'd in the Beam in manner following; *viz.* its Back to bear againſt the Back of the Coulter-hole, its right Side above to bear againſt the upper Edge of the Coulter-hole, and its left Side to bear againſt the lower Edge of the Coulter-hole; ſo that always Three Wedges at leaſt will be neceſſary to hold the Coulter; the Poll-wedge before it, as at *i*, in *Fig.* 1. another Wedge on the left Side of it above, and a Third on the right Side underneath: The Coulter-hole muſt be ſo made, that the Coulter ſtanding thus acroſs the Hole, its Point may incline ſo much towards the Left, as to be about Two Inches and an half farther to the Left (*a*) than the Point of the Share, if it were driven down as low as it; but it never ought to be ſo low in any Plough: As to its bearing forwards, the Point of the Coulter ſhould never be before the Middle of the Point of the Share: What Angle the Coulter would make with the Bottom of the Share, may be ſeen by the Poſture it ſtands in, in *Fig.* 1. If it ſhould be ſet much more obliquely, it would have a

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(*a*) I find that ſometimes it is neceſſary in ſome of theſe Ploughs for the Point of this Coulter to ſtand yet farther on the Left of the Share's Point.

greater Force to raiſe up the Poll-wedge, and get looſe.

The Three added Coulters ſhould ſtand in the ſame Poſture with this already deſcribed, in regard to the Inclination of their Points towards the Left: And this is a very great Advantage to them; for by this means, when the Fin is rais'd up, by turning the Handles towards the Left, their Points do not riſe out of the Ground on the right Hand, as they would do without this deſcribed Inclination towards the Left; but in regard to their Pointing forwards, I find it beſt, that every one of the Three ſhould be a little more perpendicular than that next behind it. So the Coulter 4 ſtands the neareſt to Perpendicular of any of them. By this means there being more Room betwixt them above than below, they are the more eaſily freed from the Turf, whenever the Pieces, being covered with a great Quantity of Couch-graſs, or the like, riſe up betwixt them; which, tho' this ſeldom happens, makes a Neceſſity for a Man, or a Boy, to go on the Side with a forked Stick, to puſh out the Turf and Graſs, which might otherwiſe fill the Spaces betwixt the Coulters, and raiſe up the Plough out of its Work.

'Tis to be obſerved, that none of theſe Coulters ought to deſcend ſo low as the Bottom of the Share, except when you plow very ſhallow: 'Tis always ſufficient that they cut through the Turf, let the Plough go never ſo deep in the Ground.

It is neceſſary alſo, that when you plow very ſhallow, the Fin of the Share be broad enough to cut off the Fourth Piece or Furrow; elſe that, lying faſt, will be apt to raiſe up the Ground-wriſt, and throw out the Plough: But when you plow deep, the Ground-wriſt will break off this Fourth Furrow, altho' the Fin be not broad enough to reach it.

Sometimes the Firſt or left Furrow is apt to come through betwixt the Firſt Coulter and the Sheat, and ſo falls on the left-hand Side of the Plough: This is no Injury; but yet it is prevented, by letting the Second Coulter ſtand a little higher than the Third; and then the Second Furrow, holding the Firſt at its Bottom, will carry it over, together with itſelf, on the right Side by the Earth-board; but yet never ſet this, or any of the Three added Coulters, ſo high that they may not cut through the Turf. But as for the firſt Coulter, tho' it ſhould cut but an Inch or Two within the Ground, the Share will break off the firſt Furrow in raiſing it up.

Remember, as often as the Point of any Coulter is worn too ſhort, that you drive down the Coulter with a large Hammer, carried for that Purpoſe; and when it is driven low enough, faſten the Wedges again, ſo as to keep the Coulters in their right Poſtures, that their Inciſions may be all of them equidiſtant.

Fig. 18. Is a Nut, with Two of its oppoſite Corners turn'd up, by which it is driven round by a Hammer, and has ſo great a Force, that Three of them, with their Screws properly placed, hold the Piece, *Fig.* 16. as faſt to the Plough-beam as if they both were made of one Piece of Wood; but as often as the Wood ſhrinks in dry Weather, the Nuts muſt be ſcrew'd farther on, both here and in all other Places where they are uſed; particularly, thoſe which hold up the Retch; for if the Sheat ſhould once get looſe, there is no Cure but by a new one.

Betwixt this Nut and the Wood, there ſhould be a thin Iron Bolſter, about the Thickneſs of a Shilling, broader than the Nut, to prevent the Nut from eating into the Wood; eſpecially when it is to be often ſcrew'd, as on the Retch of theſe Ploughs, and moſt of all on the Hoe-plough; but ſometimes we uſe a Piece of Shoe-leather inſtead of an Iron Bolſter.

Note, There muſt be Iron Plates upon all the Coulter-holes both above and below, Three of which are ſeen on the Piece in *Fig.* 16. There is no need to ſay how they muſt be nailed on with many Nails made for the Purpoſe.

Fig. 19. Is the Iron Collar, faſtened to the Beam by Two ſhort Crooks A, B, which take hold of Two ſhort Pins driven into the Plough juſt behind the Second Coulter-hole, one on one Side, and the other on the other Side of the Beam. The Crook A is ſeen on the left Side of the Beam near *c*, in *Fig.* 2. the Crook B doing the ſame on the other Side of the Beam, which is ſeen near *a*, in *Fig.* 3. C is the Crook (for its Shape called a C) which holds the Tow-chain to the Collar by the Link D, being Part of the ſaid Chain taking hold of its Fore-claw; the other Claw taking hold of one of the Five Notches of the Collar: This Collar is partly ſeen at *d*, in *Fig.* 2. Both the Claws of the Crook (or C) turn upwards, ſo that they cannot take hold of any thing that may riſe under the Plough: The Uſe of the Notches is to help the Direction of the Point of the Share, which has been deſcribed by the prick'd Lines under *Fig.* 1. As the Point of the Share wears, it inclines a little more towards the Right, and is remedied by moving the Crook into a Notch nearer to the Left, which will direct the Point a little more towards the Left: This is more eaſy to be done here than in the common Plough, whoſe Collar moves round the Beam: We can, by changing the Crook from one Notch to another, incline the Point of the Share towards the Right or Left at Pleaſure. The Length of each Side of this Collar is a Foot long.

The Tow-chain is beſt ſeen in *Fig.* 3. where the Link Y is that which paſſes thro' the Box, and is pinned in by the Stake, as has been ſhewn in *Fig.* 1. which Stake is commonly nailed to the Box, to prevent its riſing up. When we would draw up the Plough a little nearer to the Crow-ſtaves, we take hold of the Crook by a Second or Third Link.

Note, That the Shortening of the Chain does alſo a little incline the Point of the Share towards the Left.

Fig. 20. is the Iron-wilds. The Leg A is of one Piece with that which has the Notch, and that paſſes thro' the Leg B by the Loop at *a*; both which Legs paſs thro' the Box, and are pinned in behind it, by the crooked Pins C, D. This Figure is ſeen with its Crooks on it, both in *Fig.* 1. and *Fig.* 2. *Note*, That the Holes in the Box, thro' which theſe Legs paſs, muſt not be made at right Angles with the Box, but muſt incline upwards, ſo that the Fore-part of the Wilds may be higher than the Hinder-part, or elſe the Upper-part of the Crow-ſtaves would lean quite back when the Plough is drawn. If the Beaſts that draw immediately next to the Plough be very high, their Traces muſt be the longer; elſe they and the Wilds making too ſmall an Angle with the Tow-chain at the Box, when they draw hard, the Wheels will riſe from the Ground, and be apt to overturn: This Angle I ſuppoſe ſhould not be leſs than of 160 Degrees, and the Angle made by the Tow-chain or Traces that are drawn by the Cattle that go before them, will make an Angle with the Tow-chain at the Box yet much more obtuſe. The Uſe of theſe Notches in the Wilds is, to give the Plough a broader or narrower Furrow: If the Links are moved to the Notches on the right Hand, it brings the Wheels towards the left Hand, which gives a greater Furrow; and when the Links are moved toward the left Hand, it gives a leſs Furrow, by bringing the Wheels towards the right Hand.

The Diſtance betwixt the Two Legs of the Wilds is Eight Inches and an half; the Length of the Legs is Nineteen Inches. They muſt be of convenient Strength. The Links being placed in Notches diſtant from one another, prevents one Wheel from advanceing before the other; which would happen, if the Links were both in One Notch, or in Two adjoining

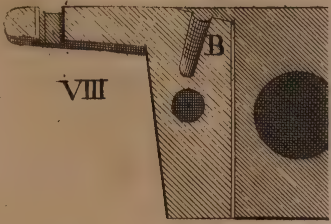
Notches, except they were middle Notches: Theſe Links are each Six Inches and an half long.

E is the Ring, by which the Two Links, and the Two Crooks F and G, are held together, and on which they all move.

The Height of the Wheels in *Fig.* 2. The left-hand Wheel is Twenty Inches Diameter; the Diameter of the right Wheel is Two Feet Three Inches; the Diſtance the Wheels are ſet from each other at the Ground, is Two Feet Five Inches and an half; the Crow-ſtaves are One Foot Eleven Inches high, from the Box to the Gallows; they both ſtand perpendicular to the Box, and the Diſtance between the Crow-ſtaves is Ten Inches and an half. The Pillow is pinned up at its Ends by Two ſmall Iron Pins, which are chained to it, that if they drop, they may not be loſt. Theſe appear in *Fig.* 1. and *Fig.* 2. The Height from the level Surface, up to the Hole in the Box, where the Tow-chain paſſes through it, is Thirteen Inches (being Two Inches below the Holes of the Wilds, on the Hinder-ſide of the Box); the Height at the other End, where the Crook of the Collar takes hold of the Pin in the Beam at *c*, in *Fig.* 2. is Twenty Inches high above the ſame level Surface, and ſhews how much the Chain deſcends forward, for drawing down the Plough, and by which Deſcent may be known what Angle the Chain would make with the Surface, if it were produced forwards in a ſtrait Line; which is a thing material for the good going of a Plough; and ſo is the Angle the Tow-chain makes with the Beam: About the Middle of this Tow-chain, there ſhould be a Swivel, whereby one End of the Chain may turn without the other.

When this Four-coulter Plough is made, I would adviſe, that it be tried with only the firſt Coulter, before the other Three are put in; for if the Plough does not go well with One Coulter, it is not likely it ſhould go well with Four; and I never yet have ſeen

VIII



XI

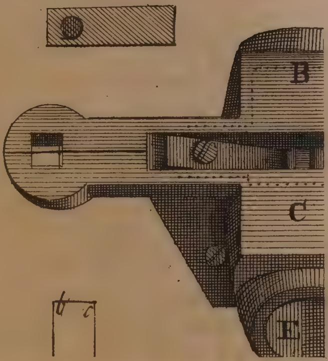
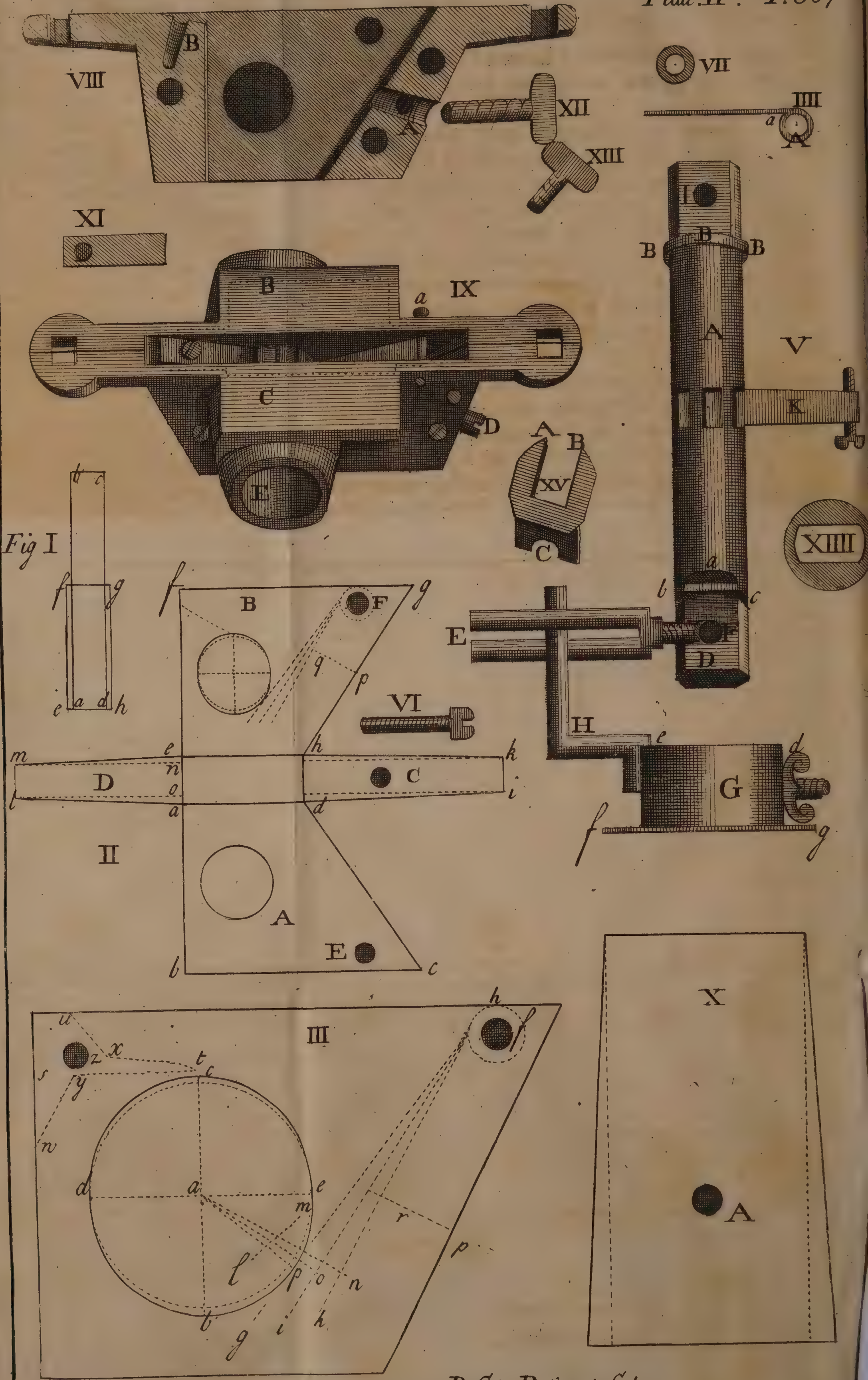


Plate II. P.307



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or heard of any that went well with One Coulter, that did not alſo go well with Four, being placed as is here directed.

The Proofs of a Plough's performing well are theſe; *viz.* If it makes a Furrow of an equal Depth on the right Hand and on the left, and turns it off fairly: If, in its going, the Tail of the Share, and the Bottom of the Drock, bear againſt the Bottom of the Furrow, and if it goes eaſy in the Hands of the Holder, without preſſing one Arm more than the other, then the Plough is certainly a good one.

The Ploughman who is accuſtom'd to a Two-wheel'd Plough, never ſuffers the Wheels to overturn, in turning out at the Land's End, from one Furrow to another; for which Purpoſe, after he has lifted the Plough a little round, he has a Knack of holding up the Crow-ſtaves with the End of the Beam, by preſſing his Hand hard againſt the Handle, whilſt the Plough lies down on one Side, until the Horſes, the Wheels, and the Plough, come near to a Line in the Beginning of the Furrow; and then he lifts up his Plough, and goes on.

CHAP. XX.

Of the Drill-Boxes.

THE Drill is the Engine that plants our Corn and other Seeds in Rows: It makes the Chanels, ſows the Seed into them, and covers them, at the ſame time, with great Exactneſs and Expedition.

The principal Parts of the Drill are, the Seed-box, the Hopper, and the Plough, with its Harrow.

Of theſe the Seed-box is the Chief: It meaſures (or rather numbers) out the Seed which it receives from the Hopper: It is for this Purpoſe as an artificial Hand, which performs the Taſk of delivering out the Seed, more equally than can be done by a natural Hand.

It is deſcribed, together with ſome of its Appurtenances, in *Plates* 2 and 3.

The MORTISE.

As the Seed-box is the principal Part of a Drill, ſo is the Mortiſe the principal Part of the Seed-box.

The following Deſcriptions ſhew how this Mortiſe differs from a common Mortiſe.

Fig. 1. *Plate* 2. ſhews both the upper and lower Edges of a Turnep Seed-box, and the Manner how they are poſited one over another. *a b c d* is a rectangled Parallelogram, and ſhews the upper Edges (or Top) of the Mortiſe. *e f g h*, being a Figure of the ſame Denomination with the former, is the lower Edges (or Bottom) of the Mortiſe. The Line *e h* is the Length of the lower Edge of the Hinder-end of the Mortiſe. *a d* is the upper Edge of the Hinder-end of the Mortiſe, and poſited juſt over the lower Edge of the ſame End. The Space between the Line *a b*, and the Line *e f*, ſhews half the Exceſs whereby the Bottom of the Mortiſe exceeds the Top in Breadth; as the Space on the oppoſite Side, betwixt the Line *c d*, and the Line *g h*, ſhews the other Half of that Exceſs; both which Halves, taken together, ſhew the whole Bevel (or Angle of Inclination) deſcribed in *Fig.* 2. That Part of the Line *a b*, from the Angle at *b* to the Line *f g*, which interſects it, ſhews the Exceſs whereby the Top of the Mortiſe exceeds the Bottom in Length.

Fig. 2. Is the Mortiſe cut down by its Four Corners, and laid open. *a b c d* is a Trapezium, with Two parallel Sides, and mark'd A, the right Side of the Mortiſe; its oppoſite Side *e f g h*, mark'd B, the left Side of the Mortiſe; the Areas of both being true Planes (*a*).

dikb Shew the Fore-end of the Mortiſe, mark'd C. *alme* ſhew the Hinder-end of the Mortiſe, mark'd D. *adbe* ſhew the Bottom of the Mortiſe already deſcribed in *Fig.* 1. If theſe oppoſite Sides and Ends were all raiſed up, until the Angle at *b* join the Angle at *l*, and that at *m* join *f*, and that at *g* join *k*, and that at *i* join *c*, the Top of the Mortiſe would be formed, and the ſame with the Parallelogram *a b c d*, in *Fig.* 1. and then the intire Mortiſe of the Turnep Seed-box would appear in its true Form, ſtanding upon its Bottom.

This differs from a common Mortiſe, in that it is impoſſible to fit it with a Tenon; becauſe it is narrower above, and ſhorter below, as in *Fig.* 1.

The Areas, or imaginary Planes, of the Top and Bottom of the Mortiſe, are parallel to each other, but not equal.

Its Two oppoſite Sides are equal, but not parallel, by reaſon of their Inclination to each other upwards, which is the Bevel hereafter to be deſcribed.

The Two Ends are neither parallel nor equal, becauſe the Hinder-end D is perpendicular to the Top and Bottom, and the Fore-end oblique, and therefore longer.

(*a*) Take care that theſe oppoſite Sides be ſure to be true Planes, eſpecially all that Part of their Areas, that is before the tranſverſe Axes of their Ellipſes herein after deſcribed; for ſhould they be otherwiſe, the Bevel of the Mortiſe would be ſpoiled, and ſo would the Ellipſes, and the acute Triangles, on the Sides of the Tongue; which how neceſſary they are to be true, is ſhewn in the proper Place. Workmen are very apt to fail in this when they file by Hand, and make theſe Sides of the Mortiſe convex inſtead of plane. Therefore this might be done with leſs Difficulty, and more Exactneſs, with a File placed in a Frame, whereby it might move upon a true Level without riſing or ſinking of either End.

When Two oppoſite Sides, or Surfaces, are inclined to each other upwards, I call that Inclination a Bevel; but when they are inclined downwards, I call it a Bevel revers'd.

The Line *a e*, being the Bottom, or Baſe, of the Hinder-end D, by being longer than the Line *l m*, ſhews that the Mortiſe is bevel.

The Two prick'd Lines *m n* and *l o*, with the Line *l m*, and Part of the Line *a e*, make a rectangled Parallelogram, which ſhews the exact Depth of the Mortiſe, and forms on each Side of it a rectangled Triangle, the one *m e n*, and the other *l o a*; which Triangles being ſimilar and equal, and their acute Angles at *l* and *m* being each of Four Degrees, make the whole Bevel, or Inclination of the Sides of the Mortiſe, to be of Eight Degrees, their Hypothenuſes being the ſame with the Sides of the Mortiſe.

This End D, being raiſed up to its Place, will be at right Angles with the Plane of the Top and of the Bottom of the Mortiſe; which, being both rectangled Parallelograms, prove that Bevel, or Angle of Inclination, to be the ſame from one End to the other of the Sides, which Sides are the Hypothenuſes of thoſe Two Triangles: But this could not be proved by the Triangles in the oppoſite End C; becauſe the Baſes being the ſame with the other, and having their Legs longer, the vertical Angles at *k* and *i* are more acute. The Legs are longer; becauſe the End C, when in its Place, is not at right Angles with the Top and Bottom of the Mortiſe, as the End D is.

The next thing to be deſcribed in the Mortiſe, is the Bore, great Hole, or Perforation; which is beſt ſhewn in the Side of a Mortiſe of a Wheat-drill, being larger, as in *Fig.* 3. wherein *c e b d* is the great Hole, and is a Section of an hollow Cylinder, that paſſes through the Mortiſe, with its Axis parallel to the Edges of the Ends of the Mortiſe: This

Cylinder, being cut by the Side of the Mortiſe obliquely, and not parallel to its Baſe, is an Ellipſe.

The prick'd curve Line is a Circle parallel to the Baſe of the Cylinder, and the curve Line *b d c e* is the Ellipſis; and this Curve is more or leſs elliptical (or oval) in proportion to the Angle of Inclination, or Bevel, of the Sides of the Mortiſe.

Of this Ellipſe the longeſt Diameter (or *Axis tranſverſus) b c* is at right Angles with the upper and lower Edges of the Sides of the Mortiſe.

Its ſhorteſt Diameter (or *Axis rectus) d e* is the Diameter of the Cylinder, biſecting the *Axis tranſverſus* at right Angles in the Centre *a*; and is in this Figure one Inch and an half.

This Ellipſe being concentric with the Circle, the Letter *a* is the Centre of both.

The Semi-ellipſis *c e b* is the Part of chief Uſe; and therefore the Edge muſt of Neceſſity be ſmooth, and without Flaws, as muſt the Surfaces of the Sides of the Mortiſe betwixt the Ellipſe and the Fore-end.

The Tongue of the Seed-box *(Plate* 3. *Fig.* 1.) differs from that in the Sound-board of an Organ (from which I took the Idea of it) in Shape, in Situation, and in the Manner of its being fix'd to the Mortiſe.

The Tongue, in the Organ, is on its Surface a long Square, or rectangled Parallelogram, a little broader and longer than the Mortiſe (or Groove) it ſhuts againſt; but this Tongue on its upper Surface, which is here turned downwards, being a Plane, is a Trapezium of the ſame Shape with the Fore-end of the Mortiſe juſt now deſcribed, except that the Tongue has a leſs Bevel.

The Situation of that in the Organ is on the Outſide of the Mortiſe, which it ſhuts by its Spring behind it, and opens immediately by the Finger of the Organiſt preſſing down the Key to let in the compreſſed Air to its Pipes; but this Tongue is ſituate within the Mortiſe of the Seed-box, and placed almoſt, in a manner, diagonally; for, had it been placed like the other, the Seed getting betwixt it and the Edges of the Mortiſe, would not have given Way to its Shutting (as the Air does to the other), but have kept it always open; which would have render'd it uſeleſs for ſowing of Seeds.

The Manner of faſtening the Organ-tongue to its Mortiſe is by Parchment and Leather glu'd to its Surface, and alſo to the Sound-board, at its End which is oppoſite to that preſſed open by the Key, and ſhut by the Spring; but this our Tongue is held within the Mortiſe, and moves on an Axis, which paſſes thro' its upper and narrower End, which Axis is the Pin A (which muſt be exactly parallel to the Edge of the End of the Mortiſe), and alſo thro' the Hole *f* in *Fig.* 3. in *Plate* 2. which is ſeen in its Place at A in *Fig.* 3. *Plate* 3. and likewiſe through both Sides of the Mortiſe near their upper Edges, and as near the Fore-end of the Mortiſe as may be, without the Tongue's rubbing againſt the ſaid Fore-end.

The Breadth of the Tongue muſt be conformed to the Breadth and Bevel of the Mortiſe, and when it is on its Axis, it being raiſed tight up as far as the ſhort prick'd Line *l m* in *Fig.* 3. *Plate* 2. being One-eighth Part of the great Hole, and being there, you ſee its upper Edges touch both Sides of the Mortiſe by their whole Length; Then it is rightly made; and by this touching both Sides of the Mortiſe tightly and cloſely, when raiſed up to that Degree, it appears, that the Two upper Edges of the Sides of the Tongue are inclined to each other in an Angle that is more acute, by about One-third, than is the Angle of Inclination of the Sides of the Mortiſe.

Hence, when the Tongue is let down to its Place, there will be on each Side of it an empty Space, betwixt it and the Mortiſe, of the Form of a very acute Triangle, whoſe vertical Angle is more or leſs acute, according as the Tongue approaches nearer to, or recedes farther from the Spindle.

This *Fig.* 1. *Plate* 3. is the braſs Tongue with its Back-ſide upwards. The Two outer Lines *a b* and *c d* are the Edges of the upper Surface (tho' turn'd downwards in this Figure), which are inclined to each other, as afore-mentioned; but the Two inner Lines *e f* and *g h* are nearer to each other, whereby this under Surface is narrower than the upper: Both muſt be plain Surfaces, but the upper and its Two Edges very free from Flaws, and ſmooth, or poliſh'd.

The Reaſon why the under Surface is narrower than the upper, is to preſerve the Bevel of the empty Triangle: For tho' the Bevel of the Sides of the Mortiſe would be ſufficient for this, if both Sides of the Tongue were ſure to keep equally diſtant from the Spindle; yet as the Tongue never is ſo tight on its Axis, but that ſometimes one Corner of it may be nearer to the Spindle than the other, in this Caſe, that Side which is neareſt to the Spindle would reverſe that Bevel, ſo as to make the ſmall empty Space that is betwixt the Mortiſe and the Tongue, wider above than underneath.

C C are the Two little Knobs that prevent the Spring from ſlipping to either Side, and are at the Diſtance from one another of the Breadth of the Spring.

Fig. 2. ſhews one Side, and the Thickneſs of the Tongue the other Side, being the ſame. *a b* ſhews the poliſh'd Surface (being a true Plane), whereon the Seed runs down to the Spindle. *c d* the Backſide, which lies turn'd uppermoſt in *Fig.* 1. *b e d* ſhews one End of the hollow Cylinder of the Tongue, thro' which its Axis paſſes.

The Length of the Tongue muſt be ſuch, as will reach lower than juſt to touch the Bottom of the great Hole as a Tangent; for, if it be not longer than that, it might happen, that when the Mortiſe is empty of Seed, and the Tongue ſet up cloſe, a Wheel might, in Turning, or otherwiſe, go a little backwards, and cauſe a Notch of the Spindle to take hold of the End of the Tongue, and tear it out of the Mortiſe: Therefore let the Tongue reach a little below the Spindle, as the prick'd Line *g h*, in *Fig.* 3. of *Plate* 2. doth.

As for the Poſture in which the Tongue ought to ſtand in the Mortiſe, it is ſhewn by the Three prick'd Lines in *Fig.* 3. *Plate* 2. where the prick'd Line *g h* makes an Angle of Forty-five Degrees, being the neareſt that it can ſtand to the Spindle; the prick'd Line *i h* makes a ſomewhat greater Angle, and it is a mean (or middle) Diſtance from the Spindle; and the prick'd Line *k h* is ſuppoſed to be its greateſt Diſtance, where the Tongue makes its greateſt Angle with the Top and Bottom of the Mortiſe. If the Tongue ſtood ſo obliquely as to make an Angle much leſs than Forty-five, the Tongue would riſe too much againſt the Bevel of the Mortiſe, and the Spring would have the greater Difficulty in returning it to its Place, when driven back by the Force of the Notches.

And beſide, when the Tongue ſtood wide from the Spindle, there might be ſo much Room betwixt it and the Sides of the Mortiſe, that ſome Seeds might fall thro' there.

The Steel Spring is D, properly placed upon the Back of the Tongue, in *Fig.* 1. *Plate* 3.

At firſt, I made the Spring double, *i. e.* with Two Legs, in Imitation of that in the Organ, and faſtened into its Tongue, much after the ſame manner as the Spring of the Organ is into its Tongue or Flap, which prevents the compreſs'd Air from paſſing out of the Sound-board, except whilſt the Key is thruſt down by the Finger of the Player; but the Drill-ſpring requiring to be of a vaſtly greater Strength than that, I made it of Steel, of the Breadth of half an Inch, inſtead of Braſs Wire: This performed very well, and ſeveral Drills are yet extant, that have only this Sort of Springs: Yet I found there was great Difficulty to ſet the Legs at their due Diſtance from each other; for their Seaſoning would alter them from what they were, whilſt the Steel was ſoft: They alſo took up too much Room in the upper Part of the Mortiſe. Then, to remedy theſe Inconveniencies, I made it ſingle, with only one Leg, which by full Experience is found to be much better than the double one; it does not contain a Fourth Part of the Metal, and is moſt eaſily made, requiring none of that Trouble and Nicety that the double Spring doth. I ſhall therefore give a Deſcription of the ſingle Spring only.

B, the End of the Screw, which holds the Spring to the Tongue, thro' a Hole near the upper End of the Spring; D, the Middle, againſt which the End of the Setting-ſcrew bears.

Its Length is almoſt the whole Length of the Tongue; the End E reaching very near to the lower End of the Tongue, and the End B is as near the upper End of the Tongue; as it can be placed without touching the Cylinder of the Tongue.

The Breadth is uſually about half an Inch; the Thickneſs muſt be in proportion to its other Dimenſions, and according to the Degree of Stiffneſs required.

The longer it is, the thicker it muſt be, to have the ſame Stiffneſs; but the broader it is, the thinner it muſt be of the ſame Length; ſo that it is hard to determine its Thickneſs. It is made ſtiffer or ſtronger by being cut ſhorter; it is made weaker, or leſs ſtiff, by filing or grinding it either thinner or narrower.

The common Thickneſs is about that of a Shilling *(a)*.

The Degrees of Stiffneſs are meaſur'd in this manner; *viz.* Fix Two Boards together, leaving a Chink betwixt them, in one Place of an Inch long; lay the Spring (when ſeaſoned acroſs this Chink) with its Middle exactly over it; then put a String over the Spring, which may paſs with both Ends thro' the Chink, and tie ſo much Weight to the Ends of the String under the Boards, that will pull down the Middle of the Spring, till it touch the Chink, and is ſtrait with both its Ends: This will ſhew the Degree of Stiffneſs. But note, That the Spring muſt be crooked, and bear only upon its Ends, with the hollow Side upwards.

If ten or a dozen Pounds Weight pull it down to the Board, it is a good Degree of Stiffneſs, for a large Box: We are not confin'd to be very nice or exact in the Degree of Stiffneſs; for by our Fingers preſſing it, we that are practis'd in it, know well enough, whether a Spring be of a ſufficient Degree of Stiffneſs, without weighing it; but for ſuch who are unacquainted with them, it is beſt not to truſt to Gueſs, but Weights; and to adjuſt the Stiffneſs to that of a Spring, that has been known to perform well.

The Spring muſt bear againſt the Back of the Tongue at each End, and lie hollow in the Middle: But the Degree of Hollowneſs of the Spring is very material; for thereon depends the Diſtance of the Tongue's Motion towards the Spindle by Force of the Spring, and back again quite to the Setting-ſcrew, by the Seed that is preſs'd againſt it by Force of the Notches, when they are moved by the Wheels; becauſe the more the Spring is curved, the farther

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(*a*) Not quite ſo thick as a milled Shilling, but rather of an old broad ſtamped Shilling, which is a little thinner.

will it thruſt the Tongue from its Middle, if its Strength be ſuperior to the Force, that reſiſts it, as it ought to be when a Notch is paſſed and before the next: This Motion of the Tongue is call'd its Play.

In order to meaſure the Diſtance (or Quantity) of this Motion, we muſt conſider, that the Tongue, moving on its Axis above, deſcribes with its lower End the Arch of a Circle, the Chord of which Arch is the Meaſure required.

To meaſure this by the Angle the Tongue makes at its Centre, would be no Rule for making Boxes; becauſe ſome Tongues are longer, ſome ſhorter, in proportion to the different Diameters of the Spindles they move againſt; and yet the Play of the ſhorteſt muſt be as much as that of the longeſt, that is, it muſt deſcribe as great an Arch at the Place of Preſſure (deſcrib'd in *Fig.* 3. *Plate* 2.); and therefore the ſhorteſt Tongue would make the greateſt Angle.

A ſhort and eaſy Way, then, for a Mechanic to meaſure, is thus: Screw in the Setting-ſcrew until the Tongue come within a quarter of an Inch of touching the Spindle; then take out the Spindle, and from the Centre of the Hole draw a Line on the Side of the Mortiſe, perpendicular to the Tongue, and at the Tongue's Edge make a Mark with the Compaſſes, or a Pen; then force back the Tongue againſt the Setting-ſcrew as far as it will go (that is, until the Spring touch the whole Back of the Tongue); produce the ſaid Line to the ſame Edge of the Tongue, or ſet the End of the Rule thereon, and draw another Line, by the Rule, from the Mark to the Edge of the Tongue, when fartheſt back, and there make the ſecond Mark. The Ruler uſed this Way will ſhew both the Perpendicular, and the Meaſure.

But yet a quicker Way is, to ſet the Tongue, by the Setting-ſcrew, up to the Edge of the Hole; and, when it is forc'd back, meaſure from the Tongue to the neareſt Part of the Hole, which will ever be a perpendicular Line drawn from the Centre of the Hole to the Place of Preſſure above-mentioned, and make another Mark there: Now the Diſtance between theſe Two Marks is the Meaſure (near enough) of the Tongue's Play at the Place of Preſſure. Tho' this Line drawn on the Side of the Mortiſe be not exactly perpendicular to the Surface of the Tongue, but only to its Edge; yet the Difference is next to nothing, and not to be regarded.

If its Meaſure be a quarter of an Inch, it is what Experience ſhews to be of a good Size for all Corn and Peas; a little leſs is no Harm, but greater is the moſt fatal Error, into which moſt of the Pretenders to the making of this Machine have fallen; they give the Tongue half an Inch, ſometimes Three quarters of an Inch Play. The Miſchief of this Error is yet farther increaſed, if the Spring be weak, if the Mortiſe have a too great Bevel, or if the Angle made by the Tongue at the upper Edge of the Mortiſe be too acute.

When the Tongue has too great Play, the Seed is apt to be turn'd out too faſt, or elſe too ſlow, in ſpite of the Driller. For when the Tongue is ſet at its due Diſtance from the Spindle, and is thruſt quite back by the Seed preſs'd againſt it by the Turning of the Notches; but the Spring being unable to return the Tongue to its former Place at ſuch a Diſtance, at the time of paſſing the Intervals which are betwixt the Notches; then the Space between the Spindle and the Tongue being too open, the Seed is ſent down too faſt.

To prevent that, they ſet up the Tongue to the Spindle; and then, as often as the Spring happens to overcome the Force of the Seed's Preſſure (as ſometimes it will), it is ſent out too ſlowly.

The Inequality of the Running of the Seed makes ſuch Boxes uſeleſs, which the Expence of Two-pence (for another Spring, or new Seaſoning of that) at moſt would rectify, if the Maker underſtood how to mend his own Work. If time did permit, more ſhould be ſaid on this Point, becauſe I find it is the *Pons Aſini* of a Workman. Sometimes it may be prevented, when the Spring is too hollow, and gives too much Play. Screw the Screw, that holds it on the Tongue, down cloſer, ſo that the lower Part of the Screw's Head preſs againſt the Spring, and thereby force its Middle nearer to the Tongue, until you find its Play leſſen'd to its juſt Diſtance.

The Spring, remaining in this compreſſed State, has loſt the weakeſt, and retains only the ſtrongeſt, Part of its elaſtic Force. Therefore, if you find it then too ſtiff, make it weaker by Filing or Grinding, or elſe put another into its Place, which is worth honeſtly no more than Two-pence.

This Holding-ſcrew has a pretty broad Head, and is ſcrew'd in by a Notch, like the Screw-pin of a Gun-lock.

The Hole in the Spring muſt be ſomewhat bigger than the Holding-ſcrew, becauſe the Spring muſt have room to move and play thereon.

If the Middle of the Spring were againſt the Middle of that Part of the Tongue, that is betwixt its Axis and the Place of Preſſure, the Diſtance of the Spring's Hollowneſs would be juſt half the Diſtance of the Spring's Play, to wit, the One-eighth Part of an Inch; but as the Spring does not quite reach up to the Axis, and reaches much below the Place of Preſſure, the Hollowneſs at the Place where the Setting-ſcrew bears againſt the Middle of the Spring at D, is conſiderably nearer to the Place of Preſſure than to the Axis of the Tongue; this Hollowneſs of the Spring at the Setting-ſcrew may be ſomething more than the One-eighth Part of an Inch, to give the Spring a Quarter of an Inch Play; but it ſeldom has ſo much.

Fig. 4. in *Plate* 2. ſhews the Length and Thickneſs of the Steel Spring of a Turnep Seed-box: This ſerves both for a Tongue and Spring: It is made firſt ſtrait, and then the narroweſt End of it is turned round, till it reach to *a*, and forms the Cylinder A, thro' which its Axis paſſes; but is not welded or joined to the other Part of the Spring at *a:* It is placed in the Box with the Cylinder Part underneath. The Face of this Spring is ſeen upon its Axis, mark'd K, in *Fig.* 5. Its Axis is to paſs thro' the Hole E, and ſcrew into the Hole F, in *Fig.* 2. as is ſeen more plainly at *a* in *Fig.* 9.

As the Top of every Tongue ought to be even with the upper Edges of the Mortiſe, the Thickneſs of the Cylinder of the Braſs Tongue cauſes the Hole in the Sides of the Mortiſe, into which it is held by its Axis, to be far enough from the Edges of the Mortiſe, to be bored and ſcrew'd without Danger of breaking the ſaid Edges; but the Spring of the Turnep-drill being ſo very thin, there is ſome Difficulty in making the Hole ſo high, and near the Edges: To prevent which Danger, *Fig.* 7. ſhews the End of a ſmall hollow Cylinder of Iron or Braſs, of the Thickneſs of the Mortiſe; which, being put into the Cylinder A, in *Fig.* 4. raiſes the Spring higher above the Hole; ſo that it may be made as low in a Turnep Mortiſe, as that is which holds the Braſs Tongue in the Wheat-drill. But we do not always uſe this inner Cylinder (*a*); but muſt then take the more Care in boring the Hole, or elſe it will burſt out at the Edges of the Mortiſe.

Its Shape muſt conform to that of the Braſs Tongue already deſcribed.

(*a*) For, inſtead of this, we may uſe a Bit of Woolen Cloth of the Breadth of the Mortiſe, glued on to the Bottom of the Hopper, which, filling the Vacuity above the Steel Tongue, prevents any Seed from running over it, though the Holes are bored as low in the Mortiſe as if the Cylinder *Fig.* 7. were to be uſed.

The Degree of its Stiffneſs is known by weighing, as has been directed for the other Spring; and being laid with its Face downwards over a Chink, with a ſmall Piece of Wood of the Thickneſs of a Barley-corn at each End, and a String taking hold of its Middle, and deſcending thro' the Chink, the Weight of Five Pounds, tied to the End of the String, will juſt bend the Spring, till it touch the Edges of the Chink; and this is the Stiffneſs of a Spring that has performed well, for many Years, in drilling of Turnep-ſeed.

The SETTING-SCREW.

Fig. 6. is the Iron Setting-ſcrew, which paſſes thro' the Hole in the Fore-end of the Mortiſe, *Fig.* 2. and paſſes up to the Middle of the Spring by the prick'd Line *p q* in the ſame Figure. The Uſe of this Setting-ſcrew is, to increaſe or diminiſh the Proportion of Seed to be turned out by the Notches; and this it does by forcing up the Spring and Tongue (where there is one) nearer to, or farther from the Spindle, whereby the Seed-paſſage is made wider or narrower, as is ſhewn by the Three prick'd Lines in *Fig.* 2. and *Fig.* 3.

Obſerve, that the prick'd Line *p q*, *Fig.* 2. (being the Mortiſe of the Turnep-box) ſtands higher than the ſame Line doth in *Fig.* 3. which is the Mortiſe of the Wheat-box. The Reaſon of this Difference is, becauſe the Spring in the Wheat-box bears at its lower End againſt the Tongue below the Seed-paſſage, and at its upper End below the Axis of the Tongue, whereby the Middle of that Spring is lower than the Spring of the Turnep-box, which, being both Spring and Tongue, bears againſt its Axis above, and againſt the Seed-paſſage below; therefore its Middle is higher. This Setting-ſcrew ſhould be placed perpendicular to the Tongue when at its mean or middle Diſtance from the Spindle, which may be ſuppoſed to be the middlemoſt of the Three mention'd prick'd Lines. This Setting-ſcrew ought to be ſmooth and round at its End, which bears againſt the Spring; for, if it ſhould have ſharp Corners or Edges, the Spring might be wounded by them, and in time might break there, being preſs'd by every Notch that turns againſt it; and, as I have computed it, a Spring undergoes One hundred thouſand of theſe Preſſures in one Day's Work; and yet, in my whole Practice, I have had only one Spring broken, and that was in drilling a large Sort of Peas with a Wheat-drill, and was occaſioned by a jagged End of the Setting-ſcrew, which was not placed perpendicular to the Spring, by which means the rough End of the Screw made Scratches againſt it a Quarter of an Inch long, and ſo deep, that the Spring broke off there: Let not this Setting-ſcrew be any longer than juſt to force the Tongue up to the Spindle; for, if it ſhould be longer, an ignorant Driller might happen, by the Force of the Screw, to break the Tongue, or its Axis; but in the Turnep-drill, which has only a Spring inſtead of a Tongue, the Setting-ſcrew may be a Thread or Two longer; becauſe the Spring will yield a little to it, after it touches the Spindle, and is ſometimes of Uſe in that reſpect, when the Notches are too large. This Screw muſt be of ſuch a Bigneſs, that it may not be in Danger of bending; for if it ſhould be bent, it could not be ſcrew'd up with any Certainty, becauſe its End, being crooked, would be below its Place at one Half-turn, and above it at the other Half-turn; and ſo the Spring might be ſet farther from the Spindle inſtead of nearer, and nearer inſtead of farther, by the Crookedneſs of the Setting-ſcrew. Its Head may be made with a Notch in it, to be ſcrew'd in with a Knife, or elſe with a Head like a T, to be turn'd with the Fingers, which I think is beſt, eſpecially for a Wheat-drill; becauſe as the Brine and Lime, which ſtick on the Wheat, grow drier, it will run faſter; and therefore the Setting-ſcrew muſt be frequently ſcrew'd in to leſſen the Seed-paſſage.

The Seed-paſſage, or Place of Preſſure, is where the Seed paſſes down betwixt the Spindle and the Tongue; and is in that Part where they are neareſt together; for there the Seed is preſs'd hardeſt by the Force of the Notches, which carry it down: And this Paſſage is higher or lower, as the Tongue ſtands nearer or farther from the Spindle; for as it ſtands wider, it becomes nearer to perpendicular to the Top of the Mortiſe, and then the Seed-paſſage is higher; and when it ſtands neareſt to the Spindle, then the Seed-paſſage is loweſt. This appears in *Fig.* 3. by the Three prick'd Lines *a n*, *a o*, and *a p*.

The Spindle, with its Notches, is beſt ſhewn where it is large, and made of Wood, as that of the Wheat Seed-box; it is a ſolid Cylinder that paſſes thro', and fills the great Hole, or hollow Cylinder, of the Seed-box; it is of various Lengths, according to the Diſtance its Wheels go aſunder; it is always in large Boxes the Axis of Two Wheels, and turns round with them, as the Axis of the One Wheel of a Wheelbarrow does with that: Theſe Wheels by their Circumferences meaſure out the Ground over which they carry the Seed-box, and, by the Notches in their Axis, deliver down the Seed equally, whether they move ſwift or ſlow; becauſe an equal Number of Notchfuls of Seed will be deliver'd thro' the Seed-paſſage at each Revolution of the Wheels.

The Notches reſemble thoſe in the Hinder-cylinder of a Cyder-mill, which break the Apples by turning againſt the Notches of the Fore-cylinder, as our Notches turn againſt the Tongue; and bruiſe the Apples which come betwixt them, as our Notches might ſometimes bruiſe ſoft Seeds, if the Tongue ſtood cloſe to the Notches, without any Spring behind it to give Way to their Preſſure; and return the Tongue again to its Place, at every Interval betwixt Notch and Notch.

The beſt Way, that I can think of, to ſhew the making of theſe Notches, is by a Section of the Spindle at right Angles, in the Middle of the Notches, as in *Fig.* 4. of *Plate* 3. which is a Circle whoſe Circumference is cut off by Six Notches; which ſhew the different Sort of Notches, that increaſe or diminiſh the Proportion of Seed to be carried thro' the Seed-paſſage by them: The Length of the Notches we never alter; but make them always parallel to the Axis of the Spindle, and of the Length of the Diſtance there is between the lower Ends of the oppoſite *Axes tranſverſi* of the Ellipſes, or great Holes, of the Mortiſe; for if any Part of the Surface of the Spindle ſhould be betwixt the End of a Notch and the Hole, one or more Seeds coming betwixt that Surface and the Tongue, might hold it open, and prevent its preſſing againſt the Notch, to hold the Seed therein from falling without the Turning of the Wheels.

This Proportion of Seed is alter'd by the Number of Notches, and by their Depth or Breadth, or by both. *b c* is the Depth of a Notch, which we call its Side; and is that which takes hold of the Seed, and carries it down thro' the Seed-paſſage. The Manner of cutting this is ſeen by its being a Portion of the *Radius* A *c*. The Bottom of a Notch is made in different Forms (*a*): As, firſt, it may be convex, as

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(*a*) The convex Form is beſt for turning out a great Proportion of Seed; becauſe ſuch a Bottom may be broader than one of any other Form, in a Notch of the ſame Depth and Capacity; and ſuch a Notch, having its Capacity more in Breadth than Depth, will be leſs liable to let fall any Seed without the Turning of the Wheels, than a Notch that is deeper and narrower, except it be very narrow, which it cannot be for throwing out a large Proportion of Seed; for a great Number of Notches cannot have altogether the ſame Capacity as a leſſer Number of the ſame Depth as is ſhewn by the curve Line *b d*. We may inlarge the Capacity of this Notch, by taking off the Convexity of its Bottom, as in the Bottom of the Notch ſhewn by the Line *e f*; and if we would increaſe it more, we make it concave, as *g h*.

But of whatever Sort or Dimenſions one Notch is made, all the reſt ſhould be the ſame exactly; and conſequently, the Interſtices (or Intervals) between Notch and Notch, of which the Line *f c*, being an Arch of the Circle, is the Breadth, muſt be equal *(a)*, and cannot be otherwiſe, if the Notches are all equal and equidiſtant, as they appear in the adjoining *Fig.* 5. which is a Section like the former, and ſhews Six Intervals, with their Six Notches, of the Size wherewith we drill St. Foin with high Wheels; but when we would drill very thin, it is better to have but Four or Five Notches inſtead of Six.

Fig. 6. ſhews a Notch of the Spindle. *a b* is the upper Edge of the Side of the Notch, being always an acute ſolid Angle. *c d* is the Edge of its Bottom, being always an obtuſe Angle. *e f* is the Angle made by the Side and Bottom, and is always ſhorter than the aforeſaid Two Edges, by reaſon of the Obliquity of the Two Ends; this Angle is never obtuſe, except when the Bottom of the Notch is concave. Theſe Three Lines muſt be parallel to the Axis of the Spindle.

Fig. 7. is one End of the afore-deſcribed Notch; the Line *a b* being joined to the Line *f d* of *Fig.* 6.

Depth may. The concave Notch, if it were as broad as the convex may be, would make the Interſtice, that is before it, liable to be broken out, and ſo Two Notches would become One; but the Convexity of the other ſupports the Interſtice like an Arch, and for that Reaſon may be made to reach almoſt quite to the Notch that is before it, without that Danger.

(*a*) But theſe cannot be equal, unleſs the Notches are all of equal Breadth, and equidiſtant from one another; and if they are otherwiſe, the Seed will not be equally delivered to the Ground.

and the Line *a c*, being join'd to the Line *b f* in *Fig.* 6. would be the End of that Notch in its proper Poſture; and then the Line *b c*, being an Arch of the cylindrical Spindle, would be the Edge of the upper End of the Notch. *a b c*, being the Area of this End, is a Plane, and, when in its Place, makes an Angle of Forty-five Degrees with the Axis of the Spindle. The other End is the ſame with this in all reſpects, except that, being oppoſite to it, it is inclined to it in an Angle of Ninety Degrees, at the bottom Angle of the Notch, at the Line *e f* in *Fig.* 6.

Fig. 8. is a Notch lying with its Ends near it, and is of the ſame Dimenſions with thoſe appearing in the Seed-box, *Fig.* 3.

The Cover B appears with its upper Surface rightly placed in the Mortiſe, in *Fig.* 3. of *Plate* 3. where its Breadth is ſhewn to be the ſame with that of the Mortiſe; but its Shape, and other Dimenſions, are beſt ſeen in *Fig.* 3. of *Plate* 2. where *ſ t* is its Length, and reaches from the Hinder-end of the Mortiſe, to within the Tenth of an Inch of the upper End of the *Axis tranſverſus* of the Ellipſis; its greateſt Depth is from *v* to *w*, and is made ſo deep, that its Bottom, at *w*, bearing againſt the End of the Mortiſe, may prevent its Point, which is at *t*, from ſinking down to touch the Spindle, which it neither muſt do, nor be ſo high above it as to ſuffer a Seed to paſs between the Spindle and it, tho' the Seed is not apt to paſs that Way, becauſe the Notches throw it forwards from the Cover. *z* is the Hole, thro' which an Iron Screw-pin paſſes, and ſcrews into the oppoſite Sides of the Mortiſe, to hold it firm in its Place: 'Tis made ſo thin betwixt *x* and *y* both for Lightneſs, and that the Seed may come the more freely to the Notches, without Danger of Arching at that End. The Uſe of the *Cover* is to prevent any Seed from falling down behind the Spindle.

Fig. 10. *Plate* 2. is the Fore-end of a Wheat Mortiſe, with its Hole A, thro' which the Setting-ſcrew is ſcrew'd, and paſſes up to the Back of the Tongue by the Line *q r* in *Fig.* 3.

Fig. 9. in *Plate* 3. is the hinder End of a Wheat Mortiſe, which by its prick'd Lines, and the Two right-angled Triangles they make, ſhews the Bevel of the Mortiſe, and alſo its Depth; it alſo ſhews the Difference of the Bevel of the Mortiſe, and that of the Tongue, *Fig.* 1. which is placed againſt it: Theſe Figures having been already demonſtrated in the Deſcription of the Turnep Mortiſe, and in theſe, I need ſay no more of it, but that I think theſe laſt-mention'd Figures ſufficient Directions for underſtanding and making the Mortiſe of a Wheat-drill.

Fig. 3. of *Plate* 3. exhibits to View a Wheat Seed-box, with its Appurtenances, ſtanding upon its Bottom; B the Braſs Cover; C the Tongue hanging upon its Axis; *c* the End of the Iron Screw that holds on the Spring, coming thro' the Tongue, and filed ſmooth with it; *a*, *a*, *a*, are Three Notches of the Spindle, with their bevel Ends; *b*, *b*, are Two Interſtices betwixt the Notches.

Hitherto we have been ſpeaking of the Parts contained in the Wheat Seed-box; let us now come to the Parts containing: As, firſt, *d e f g* is the upper Surface of the Braſs Seed-box, ſhewing the Top of the Mortiſe, and what it contains; *h h h*, and *h h h*, ſhew the Ends of the hollow Cylinder, and its Baſes coming out on each Side, farther than the Box; for if it did not project farther out than the Sides of the Box, the Surface of it would be ſo narrow, that it would cut the wooden Spindle by the Friction made between it and the Spindle; but the Surface, being of this Breadth, never wears into the Spindle, but makes it ſmooth and ſhining; *i i i*, and *i i i*, ſhew a Portion of the wooden Spindle (of an Inch and an half Diameter) coming out of the hollow Cylinder, on each Side of the Braſs Box.

The Spindle is kept from moving end-ways, by Wreaths, in the ſame manner as the Axis of a Wheelbarrow is; which Wreaths ſhall be deſcribed together with the Hopper. *k* is the Hole by which the Fore-end of the Seed-box is held up to the Bottom of the Hopper, by a Screw and Nut. *l* is the Hole where the Hinder-end of the Box is held up, in the ſame manner as the Fore-end is. *m n o p* ſhew where the Two Halves of the Seed-box are join'd together.

Fig. 10. ſhews the Outſide of One Half of the Braſs Seed-box. A A A ſhew the Thickneſs of the projecting Baſe of the hollow Cylinder, which is made the thicker, to the end that the Hole may be bored larger, and made an Inch and Three quarters Diameter, when a Spindle that is to go therein is required to be of that Bigneſs, by reaſon of its extraordinary Length, as it is in the Fore-hopper of the Wheat-drill. B C ſhew the Thickneſs of the Ends of the Seed-box, whereby it is held up to the Bottom of the Hopper; if they are not quite a quarter of an Inch thick, they will be ſtrong enough; eſpecially C, which is the hindermoſt, and which is never pull'd down by the Turning of the Spindle, but is rather raiſed up by it.

D is the Head of the Counter-ſcrew, to be turn'd by the Fingers, to preſs againſt the Side of the Setting-ſcrew, to keep it from turning of itſelf, when it is worn looſe.

E is the Hole for the Axis of the Tongue. F is the Hole of an Iron Screw-pin, which both holds the Cover to its Place, and alſo the Two Halves of the Box together. G is the Hole for another Screw-pin, which holds the Two Sides of the Box together. H and I are Holes for Two other Screw-pins, which likewiſe hold the Two Halves of the Box together, and are placed one above, and the other below, the Setting-ſcrew; for otherwiſe that Screw, and its Counter-ſcrew, might force open the Joining of the Box, and then the Setting-ſcrew might be looſe, and the Bevel of the Box might be altered; but theſe Screws, being one on each Side of it, prevent this Inconvenience.

Fig. 8. in *Plate* 2. is one Half of a Braſs Turnep Seed-box, lying with its Inſide uppermoſt, which ſhews the left Side of the Mortiſe, and half the Fore-end, and half the Hinder-end, of the Mortiſe, and half of each Screw-pin Hole, by which it is held up to the Bottom of the Hopper. A is half the Hole of the Setting-ſcrew, ſhewing in the Middle of it the End of the Counter-ſcrew. B is half the Hole, by which the Steel Spring-cover is held in with a Screw. All the other Holes are for the ſame Purpoſes, as have been ſhewn in the Wheat Seed-box.

Fig. 9. is the whole Turnep Seed-box, ſtanding upon its Bottom; Part of its Steel Spring-tongue appears in its Place, as alſo ſome of the Notches of the Spindle; but more eſpecially the Cover A, which differs from the Cover of the Wheat Mortiſe, this being a very thin Spring, whoſe lower End juſt reaches to touch (but not bear upon) the Spindle at the upper End of the tranſverſe *Axes* of the Ellipſes; the Mortiſe being filed away at the End, in order that the upper End of this Spring, and the Screw which holds it, may not lie above the upper Surface of the Box. This Spring is made very weak, to the end that, if by any Chance a ſoft Seed ſhould ſtick in a Notch, and be turn'd round, this Spring might ſuffer it to paſs by without breaking it. B, C, are the Two Flanks or Sides, made neceſſarily of this Breadth, for bearing againſt the Wood of the Bottom of the Hopper, to prevent the Seed from falling out betwixt the Wood and the Braſs, and that the Hole in the Hopper may be broader than this narrow Mortiſe of the Seed-box. The left Flank B, being next the wide Side of the Hopper, lies all open, except on the Outſide of the prick'd Lines, where it is covered by the Wood of the End of the Hopper, when it is ſcrew'd on to its Place; but the Flanch C, on the right Side, will be all covered by the End of the Box, that will ſtand upon it, and will reach to the prick'd Line that touches the Edge of the Mortiſe. D is the End of the Setting-ſcrew, appearing in its Place with a Notch, whereby it is to be turned by a Knife; but I think it better to have an End like a T, to be turned with the Fingers. E is one End of the hollow Cylinder, which projects beyond the Flanch, that there may be more Room for the Crank to turn (without ſtriking againſt the End of the Hopper, or againſt the Flanch) on the Outſide of the Box or Hopper; and for that, the longer this Cylinder is, the better the Braſs Spindle will turn in it.

Fig. 11. is the Spring-cover, with its Hole, whereby it is ſcrew'd into its Place, as it is ſeen mark'd A, in *Fig.* 9.

Fig. 12. is the Setting-ſcrew pointing againſt its Hole, its Head being flat, that it may be turned by the Finger and Thumb.

Fig. 13. is the Counter-ſcrew, to be turned in the ſame manner.

Fig. 5. ſhews the Braſs Spindle of the Turnep Seed-box, and the Manner of turning it againſt its Steel Tongue, or Spring; which Manner is different from that of turning the larger Spindles for Boxes of a larger Size, ſuch as the Wheat Seed-box.

This Spindle (*a*), being but half an Inch Diameter, is too ſmall to be turned by the Two Wheels, as the

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(*a*) I believe, if it were leſs by a Fourth or Third of its Diameter, it might be better, as being more proportionable to the Smalneſs of the Turnep-ſeed. I have had the Mortiſe much wider; but it cannot well be made much narrower, whilſt the Tongue the larger Spindles are; not only becauſe it would be in Danger of breaking by the Weight of the Hopper, and by the Twiſting (or Wrenching) of the Wheels; but alſo becauſe it would ſoon become looſe, by wearing the hollow Cylinder thro' which it paſſes; and it would be apt to open the Braſs Flanches from the Bottom of the Hopper, whereby the Seed might run out, beſide ſeveral other Inconveniences; all which are prevented by turning the Spindle in the manner ſhewn in this Figure; for here the Spindle never preſſes againſt the hollow Cylinder, with any greater Force than that of its own Weight, which is ſo very little, that the Friction made by it is next to nothing.

A the Spindle, exactly fitting the Bore of the hollow Cylinder; which, when it enters the ſaid Cylinder at its left End, in *Fig.* 9. will be ſtopp'd by the Wreath B B B; which Wreath, being circular, is caſt on the Spindle, and is Part of it; the other End of the Spindle will then appear without the right-hand End of the ſaid hollow Cylinder, at E in *Fig.* 9. and is kept there by the Wreath *Fig.* 14. which is to be put on upon the End of the Spindle, until it come to the Shoulder at *a*, which Shoulder is exactly even with the End of the hollow Cylinder; ſo that this Wreath will touch the End of the ſaid Cylinder by its whole Surface. Then, to fix in this Wreath from coming off, we make uſe of the Slider, *Fig.* 15. whoſe Two Claws A, B, being thruſt down by the Two Notches of the Spindle, at *b* and *c*, until its other Part C,

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Tongue is of this Faſhion; for this Steel Tongue, if narrower, would either be too ſtiff, or elſe apt to break, nor would there be room in the Mortiſe for a ſufficient Setting-ſcrew to follow it. But there is another Faſhion, wherein a narrower Braſs Tongue has a broad Spring behind it; and when it is in this Manner, the Mortiſe may be a Fourth of the Breadth of this. I have had many of theſe when I made my Boxes in Wood; but cannot deſcribe them by theſe Cuts; neither are ſuch narrow Mortiſes neceſſary, unleſs it were for drilling Tobacco-ſeed, Thyme-ſeed, or ſome other Sort of an extraordinary Smalneſs.

which is perpendicular to its Claws, comes down to the Flat of the Spindle, and environs one half of the Hole, covering the Part of the Flat which appears of a darker Colour; and then the upper Part of C, in *Fig* 15. makes one level Surface with the Flat D of the Spindle; and then the Iron Fork E, being ſcrew'd into the Hole F, holds down the Slider faſt, ſo that it cannot riſe up; and then the Spindle, being in its Place, will run round without moving endways, being confin'd by theſe Wreaths.

The Spindle being thus placed, ſo that it may turn eaſily, we place the Seed-box upon its Flanches with its Bottom upwards; and then ſetting one ſharp Point of a Pair of Compaſſes, or ſome ſuch Inſtrument, upon the Spindle, within the Mortiſe, cloſe to the Edge of the Hole or Ellipſe at the End of the tranſverſe Ax, turn round the Spindle, until the ſaid Point makes a Mark round the Spindle, which will be a Circle; by the ſame means make ſuch another Mark at the oppoſite Ax; then unſcrew the Fork, and take out the Slider, pull off the Wreath, and take out the Spindle, and cut the Notches between the Two ſaid Circles and Marks; the Edges of the Ends of the Notches muſt be Arches of theſe Circles. Theſe Notches ſhould differ from thoſe already deſcribed in the Wheat-drill, in nothing but the Smalneſs of their Dimenſions; their Depth ſhould be about the Thickneſs of a Turnep-ſeed, or ſomething deeper. The Breadth of their Bottoms is uncertain, and muſt be greater or leſs according to their greater or leſs Number; but we commonly have Seven or Eight Notches, and make them about the Breadth in which they appear in this Figure; but whatever their Number be, they muſt be all equal, and ſo muſt all their Interſtices.

G is the End of a wooden Spindle, thro' which paſſes the Iron Crank H, and is faſtened to it by its Screw and Nut, at *d*; Part of which Crank enters the Wood at *e*, which prevents its Turning in the Spindle.

This Crank, by its other End, paſſing thro' the Two Legs of the Fork E, and equally diſtant from the Top and Bottom of it, turns the Spindle by the Motion of the Wheel which is fix'd on the other End of the wooden Spindle. If this Crank were to turn the Spindle by a ſingle Pin, inſtead of this Fork, the Seed could never be delivered out equally to the Ground; for as ſoon as the Pin began to deſcend, and decline from being perpendicular to the Horizon, it would, by its own Weight falling down, turn the Spindle half round in a Moment, and there remain with its other End downwards perpendicular to the Horizon under the Spindle, until the Crank reach'd it there, and ſo no Seed would be turn'd out by one Semicircle of the Wheel, and a double Proportion would be turn'd out to the Land that was meaſur'd by the other Semicircle; but the hinder Leg of the Fork, bearing againſt the hinder Part of the Crank, prevents this Inconvenience.

The Line *f g* is Part of the Surface of a Board, thro' which the wooden Spindle paſſes, and by which it is held in its Place; as ſhall be ſhewn hereafter.

The Axis of this wooden Spindle ought to fall into a Line with the Axis of the Braſs Spindle; but, unleſs Care be taken to prevent it, the wooden Spindle will ſo much wear the Hole thro' which it paſſes, and be worn by it, as to have room in the Hole to deviate from this Exactneſs, and may deſcend ſo low, that the Crank may come out of the Ends of the Fork; and for this Reaſon it is, that the Fork is made ſo long as it is; but when this wooden Spindle does, by the Contrivances hereafter ſhewn, keep its Axis in a Line with the Axis of the Braſs Spindle, or very nearly ſo, then the Legs of the Fork need be no longer than half an Inch; and in that Caſe, the Joint of the Crank, which is perpendicular to the

Spindle, muſt be ſhorter, or elſe deſcend deeper into the Wood, ſo that its End, which turns the Fork, may be in the Middle betwixt its Bottom and the End of its Legs.

The Uſe of the other End of the Spindle is this: When we have a mind that it ſhould be turned by the left Wheel inſtead of the right, we ſcrew in the Fork into the Hole I, and place a ſhort Screw in the room of the Fork, to hold down the Slider.

Note, It is not abſolutely neceſſary, that the hollow Cylinder, which appears on the Sides of the Seed-box, ſhould both, or either of them, project farther than the Flanches; but I think it better that it ſhould do ſo, at leaſt, on that Side which is next to the Fork.

This Cylinder ſhould be bored as true, and as even, as the Barrel of a Fuſil is bored; and the Edges and Surfaces of its Ends muſt be ſmooth, and without Jaggs, to the end that the Wreaths may turn glibly againſt them.

The Figure or Shape of all Sorts of Seeds diſpoſes them, more or leſs, to form an Arch, when they are preſſed from above, and confin'd on all Sides.

The moſt effectual Way to prevent this is, to take care, whenever many Seeds are to deſcend together by their own Gravity thro' a narrow Paſſage, that ſuch Paſſage be never narrower downwards than upwards; but, on the contrary, that it be wider downwards, on ſome or one of its Sides; in which Caſe, if the Surfaces of all the Sides of this Paſſage be ſmooth, it is impoſſible, that Seeds ſhould of themſelves form an Arch therein.

On this Maxim depends the infallible Performance of a Drill, and from hence are derived the Uſes of the Bevel of the Mortiſe: What I mean by the Word Bevel, in general, has been already defin'd.

The Bevel of the Mortiſe of the Seed-box is that Inclination of its Sides, whereby it is wider downwards,

wards, and narrower upwards; by which means the Seed is prevented from arching in the Mortiſe before it deſcends to the Notches of the Spindle. And this is the Firſt Uſe of our Bevel; for this Arching might happen in the Mortiſe, if the Planes of its Sides were parallel to each other; and would be unavoidable, if their Inclination were downwards, as it is upwards; but theſe Planes opening downwards, the lower the Seed deſcends, the more Room it has to expand; ſo that the very Weight, which would otherwiſe cauſe it to arch and ſtop, does by means of this Bevel force it to deſcend to the Notches, and then it is ſafe from all manner of Danger of ſtopping. The Ends of the Mortiſe are at ſuch a great Diſtance from each other, and the Cover ſo very thin, as to lie almoſt even with the upper Part of the Spindle, that the Seed can never form an Arch that way; or, if it did, the continual Motion of the Tongue would immediately break it down at the Fore-end of the Mortiſe.

The Second Uſe of this Bevel is, that it gives room for the Tongue to be in the ſame manner bevel, tho' in a leſs Degree: By this means, the Seed cannot by any Impediment be ſtopp'd in its oblique Deſcent to the Notches, from the Fore-end, and all that other Length of the Mortiſe, along and upon the Surface of the Tongue.

But if the Mortiſe had not this Bevel, the Tongue could not have it; for then either the upper Surface of the Tongue muſt have no Bevel at all, which would deſtroy the Two empty Triangles which ought to be on its Sides; or elſe it muſt have a Bevel the contrary Way (*i. e.* a Bevel revers'd), and be narrower downwards than upwards, which would cauſe the Seed to arch thereon, and hinder its free Deſcent to the Notches.

A Third great Uſe of this Bevel is, that, beſides the Bevel of the Tongue aforemention'd, it gives place for Two empty Triangles, one on each Side the

Tongue, which have each its vertical Angle extremely acute at the Axis of the Tongue, and have their Baſes at the Bottom of the Mortiſe, and of the Tongue: Theſe Triangles are alſo Bevels, which conſiſt of the Difference, or Complement, of the Bevel of the Tongue, and that of the Mortiſe, the latter being about One-third greater than the former; *i. e.* One-third of the whole Bevel of the Mortiſe is divided between theſe Two Triangles, to each a Sixth Part; ſo that if the Angle of Inclination of the Sides of the Mortiſe were Nine Degrees, then the vertical Angle of each of theſe empty Triangles would be of One Degree and Thirty Minutes, and Six Degrees, would be left for the Bevel of the Tongue. And theſe triangular Spaces help to ſecure the free Motion of the Tongue, and free Deſcent of the Seed down its Surface; becauſe they permit no Impediment to lodge in them, they being, by means of the Bevel of the Mortiſe, wider downwards, both obliquely and perpendicularly, ſo that no Duſt, nor whatever elſe happens to get in betwixt the Tongue and the Side of the Mortiſe, can reſt there; for it will be immediately removed thence by the Motion of the Tongue, and its own Gravity, and either thrown perpendicularly down, or elſe obliquely to the Notches, and the firſt Notch that takes it will carry it out at the Seed-paſſage.

The Fourth Uſe of the Bevel is, that thereby the Sections of the hollow Cylinder (before deſcribed) do form Ellipſes inſtead of Circles; which they muſt have been, if cut parallel to the Baſes of that Cylinder; and the Sections muſt have been thus parallel, had the Mortiſe been without any Bevel.

Now the Two Semi-ellipſes, which are on the Fore-ſides of their longeſt Axes or Diameters, and next to the Tongue, are oppoſite to, and do ſtill uniformly depart from each other, even from the upper End of their ſaid longeſt Axis, until they arrive at the lower End of the ſame Axis, which is below the Seed-paſſage, as its upper End is very near the Cover.

This Opening of theſe oppoſite Semi-ellipſes makes it impoſſible for any-thing, of itſelf, to get into the remaining Parts of this hollow Cylinder, betwixt them and the ſolid Cylinder, call'd the Spindle, which turns continually therein, when the Wheels are going: For you will ſee, that if you make a Mark on the Spindle, cloſe to the Side of the Mortiſe, at the upper End of the longeſt Ax of the Ellipſe; and then turn the Spindle until this Mark come againſt the lower End of the ſame Ax; and there make another Mark on the Spindle, cloſe to the Side of the Mortiſe; and draw a Line from one Mark to the other, parallel to the Ax of the Spindle, which will be the Meaſure of that Part of the Bevel of the Diameter of the Hole; every Point in this Line will, by an intire Revolution of the Spindle, generate a Circle, which will cut the Ellipſe in Two Places, once on the Fore-ſide of its longeſt Axis, and once on the Back-ſide or hinder Half of it; and that all theſe Points, in this Surface of the Spindle, deſcrib'd by theſe Circles, will enter the Hole, by the ſaid hinder Semi-ellipſe, as the Spindle there turns upwards (as it always does); and they will all again come out on the fore Semi-ellipſe, as they deſcend towards the lower End of the ſaid Ax of the Ellipſe.

As theſe Points thus come out of the Hole, or (if I may uſe the Expreſſion) as they emerge, they oppoſe every thing that would enter the Hole, they ſtill moving from the Hole, and puſh away from it whatever they meet; nay, if any thing were in the Hole, theſe Points (whereof this Surface conſiſts) would bring it out by this Semi-ellipſis, which is always preſs'd by the Seed when the Drill is at Work; but as theſe Points immerge by the other Semi-ellipſis which is behind the Spindle, they can carry with them into the Hole nothing but Air, becauſe the Cover never ſuffers any thing elſe to come there from above; and the Seed falls out of the Notches by its own Gravity, juſt before it reaches the lower End of the tranſverſe Ax, being the Place where the oppoſite Ellipſes are fartheſt aſunder; and none of it is ever carried ſo far back as the hinder Semi-ellipſes; and therefore nothing can be carried into the Hole from below.

Thus that Part of the Surface of the Spindle will keep the Hole empty and clear, before ever any Notches are cut; but when the Notches are made on the Spindle, they have yet a much greater Force to drive and expel whatever would enter the Hole, their Shape being ſuch as nothing can enter againſt their bevel Ends; but what is at their Ends will be thrown preſently into the Mortiſe; inſomuch that when a Spindle has been too little for the Hole by a Quarter of an Inch, that is, a ſixth Part of the Diameter of the Hole, it will perform very well in drilling large Species of Seeds; and when the Mortiſe is run empty, nothing at all is found in the Hole, it being thus kept void and clean by the Notches.

Note, That what is here, and elſewhere, ſaid of the Ellipſe of the one Side of the Mortiſe, muſt be underſtood the ſame of its oppoſite Ellipſe, on the oppoſite Side of the Mortiſe.

All theſe Advantages accruing from this Bevel of the Mortiſe, I believe that, without it, all Attempts of making a Machine to perform the Work which this does, would have been vain.

There is alſo within the Mortiſe unavoidably another Bevel, which is as the Reverſe of the former, and notwithſtanding is as uſeful; and this Bevel is, the Inclination which Part of the curvilineal Surface of the Spindle, beginning a little above the fore End of the ſhorteſt Diameter of the Ellipſes, and deſcending down to the Seed-paſſage, has to the lower Part of the Surface of the Tongue oppoſite againſt it. Theſe Two Surfaces meeting one another below, when the Tongue is ſet up cloſe to the Spindle, form a mix'd Angle, which ſtops up the Seed-paſſage, except when a Notch comes againſt it.

When the Tongue is ſet from the Spindle, to the Diſtance of ſeveral Diameters of one of the Seeds that are to be drill'd, this revers'd Bevel cauſes the Seed to arch at the Seed-paſſage, and ſtop there, till the Notches force it thro', which would, without this Arching, fall out by its own Gravity, without the Turning of the Wheels.

The Seed arches here the more firmly, the more it is preſs'd upon by the incumbent Seed from above it; and the former Bevel (which I call the Bevel of the Mortiſe) permits the incumbent Weight to preſs the harder on the Seed that is near the Seed-paſſage; and this might be reckon'd a fifth Uſe of the former Bevel: For as it prevents the Seed from arching in any other Part of the Mortiſe, ſo it does, by the ſame means, cauſe it to arch the more ſtrongly at the Seed-paſſage, which is ſometimes (*viz.* when the Tongue muſt be ſet wide) as neceſſary, as it is for it to eſcape arching before it comes thither. And the more ſtrongly this Arch preſſes againſt the Tongue, the more the Tongue by its Spring preſſes againſt it; and this Preſſure being reciprocal and equal, the Seed cannot fall out ſpontaneouſly; for when the Paſſage is thus wide, if you throw into the Mortiſe a few Seeds, ſuppoſe Five or Six at a time only, they will all paſs through immediately, without any Motion of the Wheels; but if you throw in a large Quantity together, there will only a few of the lowermoſt fall through, unleſs the Wheels do turn and throw them down by the Force of the Notches.

Indeed we do not care to ſet the Tongue ſo very wide from the Spindle, unleſs it be when we are obliged to plant a very much larger Proportion of Seed than the Notches are deſign'd for, and when we have no Opportunity of changing the Wheels for ſuch as are lower, nor of changing the Spindle for another that has greater or more Notches in it.

Four-and-twenty Gallons of large Peas are as proper a Proportion to drill on an Acre, as Six Gallons of Wheat are.

There are divers Ways to vary (*i. e.* increaſe or diminiſh) the Proportion of Seed; as, Firſt, by the Setting-ſcrew, with which we can, without any Inconveniency, ſet the Tongue ſo far from the Spindle, as to permit one Round of the Notches to turn out Four times the Quantity, as it will do when the Tongue is ſet cloſe up to the Spindle; and thus we can vary the Proportion by innumerable intermediate Degrees.

Next, if we would increaſe the Proportion yet farther, we can inlarge the Notches; but we cannot add to their Number, unleſs there be room to double it, by making a new Notch between every Two; but we cannot diminiſh the Proportion of Seed by the ſame Notches, becauſe they cannot be made leſſer or fewer.

If we would make any other Alteration in the Proportion of Seed by the Notches, it muſt be done by making another Set of them; which we may do, becauſe the wooden Spindle may have Three Rows of Notches in it, of which we may uſe either, by moveing the Wreaths and Wheels towards one End or the other of the wooden Spindle; as ſhall be ſhewn in the Deſcriptions of the Hoppers.

But as for the Braſs Spindle of the Turnep-drill, we can have but one Set of Notches in it (*a*): And there-

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(*a*) But by putting on a Wreath (that is a little broader than the Mortiſe) upon the Spindle (made longer for that Purpoſe) we can, by changing this Wreath from one End of the Spindle to the other, have Two ſets of Notches of different Sizes, and of different therefore, tho' we can increaſe the Proportion of Seed by inlarging the Notches, or perhaps by doubling their

different Numbers in it: Or if we would have Three Sets, we need only make uſe of Two ſuch Wreaths, and let the Spindle be long enough to receive them. So we may uſe which Set we pleaſe.

Tho' ſeveral Sets of Notches may be uſeful to thoſe who drill many Sorts of fine Seeds different in Magnitude in a very great Degree; yet I never found more than one Set of Notches neceſſary in this Spindle.

Nor have I uſed any more than one Set of Notches in one Mortiſe of any Sort; but in a wide Mortiſe, there may be made a double Set of Notches, conſiſting of Two Rows, all of equal Bigneſs, and half of the Length, and double the Number of a ſingle Row, one End of each Notch reaching to the Middle of the Mortiſe, and pointing againſt the End of an Interſtice, that is between Two of its oppoſite Notches.

If ever there ſhall be Occaſion of this Sort of Notches, it muſt be when a great Proportion of Seed is to be drill'd by a ſmall Spindle, and low Wheels: The Smalneſs of the Spindle may not, by a ſingle Set, admit of a ſufficient Number of Notches (of a proper Bigneſs) in its Circumference; not that a double Set, by its double Number, will throw down a greater Quantity of Seed than a ſingle Set of the ſame Width and Depth, but a leſs Quantity: But it may be feared, that a very ſmall Number of Notches might not ſpread the Seed ſo much as to cauſe it to lie even in the Chanels, one Notchful falling all to the Ground, before any of the next Notchful reaches it, which would make Chaſms or Gaps in the Row of Corn or Legumes: This, ſuch a double Number of Notches will certainly prevent.

It would ſeem, that the higher the Wheels, the more need there ſhould be for this double Set of Notches: But it appears to be otherwiſe; for the greater Diſtance the Seed has to fall, the more it ſpreads, and ſtrikes oftener againſt the Funnel and Trunk; and by that means a Notch from high Wheels will, with the ſame Quantity of Seed, ſupply a greater Length of the Chanel (or Furrow) than a Notch will from low Wheels.

In all my Practice I never had any Occaſion for ſuch a double Set of Notches, either with high or low Wheels, or even when I drilled into open Chanels, without Funnels or Trunks to my Drill-plough; and yet my Rows of St. Foin, and of Corn, were always free from Gaps, being equally ſupply'd with Seed from one End to the other.

If ever there is occaſion for more than a ſingle Set, it muſt be for Beans, for which alſo I think a large Spindle is better than a double their Number; yet we cannot leſſen the Proportion of Seed by the Notches, unleſs we have a new Set of them, and that will occaſion a Neceſſity of having another Spindle; but, as to the Setting-ſcrew of the Turnep-drill, it will increaſe the Proportion of Seed with the ſame Notches, much more than the Setting-ſcrew of the Wheat-drill will do.

The other Way of varying the Proportion of Seed in the ſame Boxes, is by the Diameter of the Wheels, when we can alter them; for Wheels, of what Diameter ſoever they are, muſt turn round all the Notches at one Revolution; ſo that Wheels of Twenty Inches Diameter will deliver out a third Part more Seed than Wheels of Thirty Inches Diameter, into the ſame Length of the Chanels; but we ſeldom have any Occaſion to alter the Wheels, unleſs it be on account of planting a Species of Seed of a different Magnitude, as the largeſt Sort of Peas, and ſmall-grain'd Wheat, or St. Foin Seed are.

Theſe are all the Ways we have to alter the Proportion of Seed, we drill with the ſame Seed-boxes;

double Set of Notches in a ſmall one. The largeſt Spindle I have known made, is of Two Inches and an half Diameter, and that only for Horſe-Beans.

The beſt Sort of Notches for a double Set are thoſe which have convex Bottoms; becauſe ſuch are leſs liable to drop their Seeds without the turning of the Wheels, than any other Sort: And a double Set muſt be in greater Danger of this, as the Tongue is always hindered from preſſing ſo cloſely againſt any Notch, being held open by the Seeds on the oppoſite Interſtice; which is contrary to a ſingle Set, where no Seed can lodge at either End of a Notch, to hold open the Tongue, or hinder its preſſing againſt it.

Note, When I made my Boxes of Wood, I had double Boxes, with a Partition between ſuch a double Set of Notches; but never made ſuch in Braſs, not knowing whether that Partition, by its Thinneſs of hard Metal, might not cut the Spindle: Yet I never found any occaſion for a double Row of Notches. I made thoſe double Boxes only for drilling Two Sorts of Seeds at once into the ſame Chanel.

theſe Two Sizes, already deſcribed, being ſufficient for all Sorts of Corn and Seeds which we commonly ſow, from Marrow-peas to Turnep-ſeed; but, for drilling of Beans, the Boxes muſt be larger, and are commonly made of Wood, the Spindle Two Inches Diameter, or more, and the Boxes Two Inches wide; Where note, That this Increaſing of the Width of the Mortiſe, from an Inch and an half, to Two Inches, increaſes the Quantity of Seed to almoſt double; becauſe this Half-inch is all added to the Middle of the Notches, where they are deeper than their Ends; the Bevel of which takes up a conſiderable Part of the Length of the Notches. For Beans, they alſo contrive to have their Wheels as low as conveniently they can. Theſe Wooden Drills are now become common in many Places.

The Wooden and Braſs Seed-boxes differ not in any of the moſt eſſential Parts of them; only the Wooden Box muſt be thicker, as the Wood is not ſo ſtrong as Braſs; the Spring is made ſtrait inſtead of crooked; and, being let into the Back of the Wooden Tongue, bears againſt it at each End; and the Chanel, into which it is placed, being made hollow in the Middle, the Spring has its Play there, and muſt be ſtiffer, and have a little more Play in the Bean-drill, than in any leſſer Seed-box.

I, at firſt, made all my Seed-boxes of dry Box-tree Wood, which perform'd very well, and are ſtill uſed: But, a few Years ago, a Gentleman adviſed me to make them in Braſs; the doing of which has put me to a great deal of Trouble and Expence, for want of underſtanding the Founder's Art: Yet this I do not repent, becauſe they are, in ſome reſpect, better than thoſe made in Wood; eſpecially to thoſe who do not well underſtand their Fabric; for, to ſuch, the Swelling and Shrinking of the Wood was inconvenient in ſmall Boxes: And I now am told, that they are caſt in *London* of the beſt Braſs, at the Price of One

Shilling *per* Pound, and ſo ſmooth as to require very little Filing. And theſe Braſs Boxes being alſo more laſting than Wood, and not much more expenſive, when Workmen know how to make them, I think it not worth while to give any particular Directions for making them in Wood.

As to the Spindles of the Turnep-boxes, I have often made them with a mix'd Metal, of half Pewter, and half Spelter, which perform very well, and are eaſily made; becauſe this Metal will melt, almoſt as ſoon as Lead, in a Fire-ſhovel, to be caſt in a Mould; but Braſs will not melt without a Crucible.

The firſt Idea that I form'd of this Machine, was thus: I imagin'd the Mortiſe, or Groove, brought from the Sound-board of an Organ, together with the Tongue and Spring, all of them much alter'd; the Mortiſe having an Hole therein, and put on upon one of the Iron Gudgeons of the Wheelbarrow; which Gudgeon being inlarg'd to an Inch and an half Diameter, having on it the Notches of the Cylinder of a Cyder-mill, on that Part of it which ſhould be within the Mortiſe, and this Mortiſe made in the Ear of the Wheelbarrow (thro' which the Gudgeon uſually paſſes), made broad enough for the Purpoſe; this I hoped, for any thing I ſaw to the contrary, might perform this Work of Drilling; and herein I was not deceived.

As for placing a Box over this Mortiſe to carry a ſufficient Quantity of Seed, it was a thing ſo obvious, that it occaſion'd very little Thought; and an Inſtrument for making the Chanels, not much more; neither for applying Two Wheels, one at each End of the Axis, inſtead of the ſingle Wheel in the Middle of the Axis of the Wheelbarrow.

At firſt my Plough made open Chanels, and was very rude, being compoſed of Four rough Pieces of Planks, of little Value, held together by Three Shoots, or Pieces of Wood, which held them at a Foot Diſtance

Plate. 3

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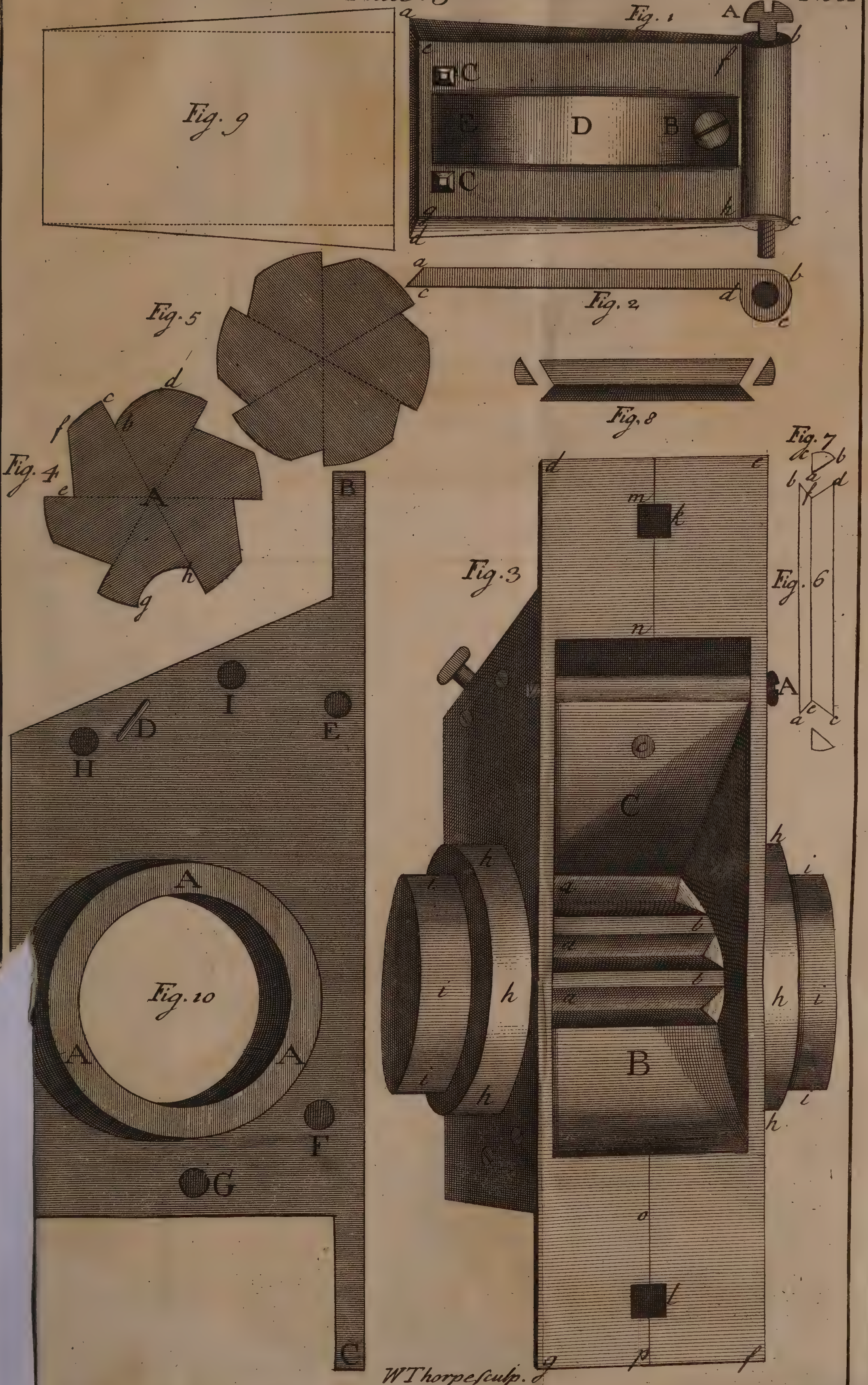

WThorpe sculp.

ſtance

ſtance one from the other: Theſe Pieces, being cut ſharp at Bottom, made the Chanels tolerably well in fine Ground. But I ſoon contrived a Plough with Four Iron Shares, to make Chanels in any Ground: This drew a Hopper after it, having Four Seed-boxes at its Bottom, carried on a Spindle by Two low Wheels, which had Liberty to riſe and ſink by the Clods that they paſs'd over: The Seed-boxes delivered their Seed immediately into the open Chanels.

This Plough and Hopper were drawn by an Horſe, and the Seed, lying open in the Chanels, was covered ſometimes by a very light Harrow, and ſometimes by an Hurdle ſtuck with Buſhes underneath it.

I ſoon improv'd this Plough to perform better, and to make Six Chanels at once, and ſometimes a great many more.

This Plough and Hopper, with their Improvements and Alterations, are ſhewn in *Plates* 4. and 5.

C H A P. XXI.

Of the *Wheat-Drill.*

FIG. 1. in *Plate* 4. is the Drill-plough, which makes the Chanels for a treble Row of Wheat, at Seven-inch Partitions, and covers the Seed by the Harrow which moves on its Beams. A is the Plank, Three Feet and an half long, Eight Inches and an half broad, one Inch and a quarter thick; its upper and under Surfaces are true Planes. B, B, the Two Beams, each Two Feet Four Inches long, Two Inches Three quarters broad, and Two Inches and a quarter deep, ſtanding under the Plank at right Angles with it, and held up to it by the Four Screws and Nuts *a*, *a*, *a*, *a*, the one being at the ſame Diſtance from the right, as the other is from the left End of the Plank.

This Plough makes its Chanels by Three Sheats, and their Shares and Trunks; the Firſt or Foremoſt of which Sheats ſtands under the Middle of the Plank, with Part of it appearing at *b*; and is fully deſcrib'd in *Fig.* 2. where A is the Tenon, of a convenient Size, Two Inches broad between Shoulder and Shoulder, Three quarters of an Inch thick: It is driven into the Plank thro' a Mortiſe, and pinn'd up by its Hole: It ſtands thus obliquely, and pointing forwards, that it may ſtand the more out of the Way of the Funnel. The Shoulder at *a* is a quarter of an Inch. The hinder Shoulder, from the Tenon to the Angle at *b*, is Three quarters of an Inch. The Depth of the Back of the Sheat, and Thickneſs of the Share, when it is on, from *b* to *c*, is Nine Inches and a quarter; and the Angle at *c* muſt be a right Angle, contrary to the Opinion of ſome, who fanſy it ought to be acute, ſuppoſing that when this Angle is right, whilſt the Seed is deſcending by the Back of the Sheat, the Plough, as it moves forwards, would get before the Seed, and ſo it might fall to the Ground behind the Trunk; but this Miſtake is for want of conſidering the vaſt Diſproportion between the Celerity of the Seed's deſcending near the Earth, and the ſlow Progreſs of the Plough; the Seed deſcending at the Rate of Sixteen Feet in a Second of Time, and the Plough proceeding but about Three Miles an Hour, does not advance the Thickneſs of a Seed, whilſt it is falling to the Ground by the whole Depth of the Sheat.

The Thickneſs of the Sheat is an Inch, at its upper Part. The reſt of it is to be no thicker, than the Breadth of the Share.

Fig. 3. is the Share, lying Bottom upwards. *a* is its Point. *b* the Socket, Three Inches long, Seven Sixteenths of an Inch broad. *c* is the Hole, by which it is faſtened up to the Sheat. *d* is another Hole, which is never made uſe of, except when the Share, being faſten'd up by the other Hole, inclines to either Side; then we draw it right by a Nail driven into this Hole. *e*, *e*, are Two very ſmall Notches, into which the Sides of the Trunk are jointed, to protect them from being torn out by the Earth or Stones that might rub againſt them. *f* is the Tail of the Share, which, when it is in its Place, will make the right Angle before deſcribed in *Fig.* 2. and from which Tail to the Fore-part of the Socket, is the Length of the Bottom of the Sheat, *viz.* Six Inches and an half. The Breadth of the Share Three quarters of an Inch.

Fig. 4. ſhews one Side of the Share. The prick'd Line *a e* ſhews the Bevel of the Fore-end of the Socket, the upper Edge of which muſt bear upon the Fore-part of the Sheat below *f* in *Fig.* 2. and the other Part of the Share will bear againſt the Bottom of the Sheat, from *d* to *c*, and will be faſtened up by a flat Nail, paſſing thro' the foremoſt Hole of the Share, and entering the Hole *g* in the Sheat; which Nail being bended in the ſaid Hole (which Hole ſhould be at leaſt an Inch Diameter) will hold the Share faſt to the Sheat; and, by unbending this Nail, the Share may be eaſily taken off, upon occaſion, without damaging the Sheat. *Note*, This Hole in the Share ought to be wider below than above, and the Head of the Nail of the ſame Shape; or elſe, as the Share wears thinner, it might come off. The prick'd Line, near the Fore-part of the Sheat, ſhews where a Shoulder muſt be cut on each Side of it, becauſe otherwiſe the Sheat, being thicker than the Breadth of the Socket of the Share, could not enter it: But take care, that the Share do not bear againſt theſe Shoulders.

Fig. 5. is one Side of the Trunk, being a thin Plate of Iron, and is often made of the Blade of an old Scythe: It is to be riveted on to one Side of the Sheat, to another of the ſame on the oppoſite Side, by Three Rivets paſſing thro' them both, with the Sheat in the Middle of them; which Holes appear both in the Plate and in the Sheat. Theſe thus riveted on do form the Trunk at the Back of the Sheat. The whole Breadth of this Plate is an Inch and Three quarters; but Three-eighths of an Inch being riveted on to the Sheat, there remains but an Inch and Three-eighths for the Trunk. The Length of the Plate is the ſame with the Depth of the Sheat and Share, except that it ſhould not reach to the Bottom of the Share, by about the Thickneſs of a Barley-corn, to the end that it may not bear againſt the Ground, as the Share doth. The Notch at the Bottom of the Plate is that which anſwers the Notch in the Tail of the Share: The Corner of the Plate at *a* we make a little roundiſh, that it may not wear againſt the Ground.

This Plate thus riveted on the Sheat, and another of the ſame Form on the other Side oppoſite to it, compoſe the Trunk, which is *Fig.* 6. *a d* is the Edge *a b* of the Plate *Fig.* 5. *b c* is the like Edge of the oppoſite Side of the Trunk. A is the Back of the Sheat, which, together with the Tail of the Share when in its Place, makes the Fore-part or Length of the Trunk. The Thickneſs of this Back of the Sheat is the Width of the Trunk; and from this Back of the Sheat to the ſaid Edges of the Plates, may be call'd the Depth of the Trunk. The upper Ends of theſe Two Plates *a* and *b* we ſpread open a quarter of an Inch wider, for half an Inch down, than the reſt of the Trunk, for the more free Reception of the Seed from the Hole of the Funnel: We likewiſe take care, that the Two lower hinder Corners of the Trunk do not incline to one another, to make the Trunk narrower than the Back of the Sheat, leſt the Earth ſhould be held in by them, and fill the Bottom of the Trunk.

Fig. 7. is one of the hinder Sheats, and appears, in part, at *c* in *Fig.* 1. It is faſtened into one of the Beams by its Tenon, which, being driven into a Mortiſe, is pinn'd in by a Pin paſſing thro' the Beam, and the Tenon cut off even with the upper Surface of the Beam: This Tenon ſtands more oblique than that of the fore Sheat, that there may be the more Wood between its Mortiſe and the Funnel, its hinder Shoulder being ſhort: Its fore Shoulder at *a* muſt be very ſhort, not above the Eighth of an Inch; but its Shoulder *b* Three quarters of an Inch. The Tenon is alſo ſhoulder'd on each Side, as well as before and behind. The Thickneſs of this Sheat ſhould be greater than that of the Fore-ſheat, becauſe it is much narrower. The Depth of this Sheat is leſs than the Fore-ſheat, by the Depth of the Beam: It is, in all other reſpects, the ſame with the Fore-ſheat, except that it and its Share are ſhorter. The Socket of this Share is but an Inch and One-eighth long, its Breadth half an Inch, and from the Fore-part of the Bottom of the Socket to the End of its Tail, but Three Inches. Its Point from the Socket at Bottom is but Three quarters of an Inch, whereas the Point of the Fore-ſhare is an Inch and Three quarters: There is but one Hole whereby the Share is faſtened up to the Sheat. Its Trunk is no wider than the other; for we cut a Rabbet on each Side of the Sheat, that the Plates, which are the Sides of the Trunk, may come within Three quarters of an Inch of one another. Its Tenon, being narrower than the Tenon of the Fore-ſheat, muſt be thicker than it.

The other Hinder-ſheat, and all its Accoutrements, muſt be the ſame as this of *Fig.* 7.

The Workman muſt take care, that the Tenons of the Sheats be not made croſs the Grain of the Wood; and therefore muſt make them of crooked Timber.

Fig. 8. ſhews how the Share is made of Four Pieces; of which *a* is a Piece of Steel for the Point, its larger End being cut bevel for the Shape of the Fore-end of the Socket. *b* is a Piece of Iron for the other End of the Share, from the Socket to the Tail: The other Two Pieces *c* and *d* are the Iron Sides, which, being welded on to the other Two Pieces, and cut off to the Length, form the Share, with its Socket, more exact than it can be made out of one Piece of Iron.

Now we return to the firſt Figure; where the Fore-ſheat being fix'd up at equal Diſtance from each End of the Plank, and as near to the hinder Edges of it as can be, allowing room for the Funnel C to ſtand with the Fore-ſide of its Hole, to make one Surface with the Back of the Sheat, and for the hinder Part of the Trunk not to reach the Edge of the Plank, there muſt be alſo room for the Fore-ſtandard D to ſtand perpendicular to the Plank, acroſs the Tenon of the Sheat.

This Standard being cloſe to the Fore-ſide of the fore Hopper, there muſt be ſo much room between it and the Hole of the Funnel, that the Seed may drop from the Seed-box into the Middle of this Hole. Thus much for placing the Fore-ſheat.

Next, for the Two hinder Sheats; they muſt be placed at equal Diſtance from the Sides of the Beams, and ſo near to the hinder Ends of the Beams, that there may be room to make the Funnels in them, and their Tenons to come up between their reſpective Funnels E and F, and their reſpective Standards G and H, which Standards muſt be ſet perpendicular to the Beams.

The Diſtance of theſe Sheats from the Plank muſt be ſuch, that the Wheels of the hinder Hopper may not ſtrike againſt the Plank, nor againſt the Spindle of the fore Hopper; and the Semidiameters of theſe Wheels being Eleven Inches, there ought to be a Foot between the Centre of each Wheel and the Plank; but we ſometimes cut Notches in the Plank, to prevent the Circle of the Wheels from coming too near the Plank.

For the nearer the hinder Sheats ſtand to the Plank, the better; but theſe Beams may be placed nearer to, or farther from the Plank, by their Screws and Nuts, at Pleaſure.

Theſe Beams muſt be ſet at ſuch a Diſtance from one another, that the Shares may be Fifteen Inches aſunder from the Inſide of one to the Outſide of the other.

To try whether all theſe Sheats and Shares are truly placed, ſet the Plough upon a level Surface; and then, if they be right, the Fore-ſhare will touch that Surface by its Point and Tail, and likewiſe the hinder Sheats will do the ſame; except that ſome Workmen will have it, that the Plough goes better, when the Tails of the hinder Sheats are a Barley-corn's Thickneſs higher than their Points; and then their Tails will want ſo much of touching the Surface.

The Shares muſt be all of them parallel to the Beams, and conſequently to one another.

The Chanel made by the fore Share and Sheat for the middle Row, being at equal Diſtance between the Two hinder Sheats, is covered by them, they raiſing the Mould over the Seed from each Side of this Chanel.

The Harrow I is drawn by the Beams, to which it is faſtened to their Inſides at *d* and *e*, having each a ſmall Iron Pin, paſſing thro' each End of the Legs of the Harrow, and thro' the Beams; each having a Nut on the Outſides of the Beams, and being ſquare in the Beams, that they may not turn therein to looſen their Nuts; but are round near their Heads, that the Harrow may eaſily move thereon.

The round Ends of the Legs of the Harrow are put thro' its Head I, at the round Holes *f* and *g*; and pinned in behind it, to the end that either Tine of the Harrow may deſcend at the ſame time that the other riſes, where the Ground is uneven.

The Two wooden Tines K and L are pinned in above the Head, and have each of them a Shoulder underneath. They ſtand ſloping; ſo that if they take hold of any Clods, they do not drive them before them, but riſe over them. They are of a convenient

Length, to give room for the Harrow to ſink and riſe, without raiſing up the Shares; and to give them the more room to move: The Legs of the Harrow are crook'd downwards in the Middle.

The Diſtance of theſe Tines from each other is Twenty-two Inches; ſo that each Tine going Three Inches and an half on the Outſide of each Chanel that is next it, fills it up with Earth upon the Seed, from the Outſides of it; which cauſes the Rows to come up ſomething nearer the inner Sides of the Chanels, than to the outer Sides, from whence the Earth is brought into them by the Tines; and the Two outer Rows by this means come up at Fourteen Inches aſunder, tho' the Chanels were Fifteen Inches aſunder.

This way of covering adds more Mould to the Top of a Ridge; whereas, if the Chanels were covered by Tines going within or between them, the Mould would be thrown down from the Top of the Ridge: And theſe Tines ſtand with their Edges and Points inclining outwards, by which means they bring in the more Earth to the Chanels.

If we find, that the Harrow is too light, we tie a Stone upon it to make it heavier; and ſometimes we fix a ſmall Box of Board on the Middle of it, to hold Clods of Earth for that Purpoſe.

The fore Funnel C has its upper Edges Two Inches high above the Surface of the Plank. It is Five Inches Square at Top; its Four oppoſite Sides being Planes equally inclin'd to each other downwards, until they end at the Hole in the Bottom of the Funnel, which Hole is continued quite thro' the Plank into the Trunk. The Shape of this Hole is ſhewn in *Fig.* 9. where the Four Lines *a b*, *b c*, *c d*, and *d a*, each Line being Three quarters of an Inch, make a true Square, and are the upper Edges of the Hole. The Three prick'd Lines *e f*, *f g*, and *g h*, being each of them longer than the former, tho' as little as poſſible, make the Three lower Edges of the Hole; which being thus wider below than above, and having all its Sides true Planes and ſmooth, it is impoſſible for the Seed to arch therein. The fore Side of this Hole is perpendicular to the upper and lower Surfaces of the Plank, and, together with the Back of the Sheat, makes one plane Surface.

When we drill a large Species of Seed, as Peas or Oats, we can make this Hole a full Inch ſquare at Top, and of the ſame Shape wider at Bottom; which tho' it be wider than the Trunk, except at its Top, the Seed will not arch there, becauſe there is room behind, the Plates being broader than the Sides of the Hole; for there can be no Arching in the Trunk, unleſs the Seed were confin'd behind as well as on each Side.

The Holes of our Funnels ought to be of the ſame Shape with this deſcribed; tho', as I am inform'd, the Pretenders to the making of this Plough make the Holes of their Funnels the Reverſe of this; which being wrong-way upwards, the Seed is apt to arch in them, except the Holes are very large.

Of this Plough, *Fig.* 1. the Two hinder Funnels E and F differ from the fore Funnel (which has been deſcribed), firſt, in Dimenſions; theſe not being ſo deep, becauſe they being made in the very Beams, their upper Edges are in the upper Surface of the Beams, and their Holes at the Bottom, being about the Eighth of an Inch deep. The Depth of the Funnels muſt want the Eighth of an Inch of the Thickneſs of the Beams; but we make each Funnel an Inch and a quarter broader at Top than its Beam, by adding a Piece of Wood to each Side of its Beam, which reaches down about half-way its Thickneſs; and theſe Pieces being firmly fix'd on by Nails, to the Sides of each Beam, the Legs of the Harrow take hold of theſe Pieces, which are in the Inſide of theſe Beams. When the Plough is taken up to be turn'd, the Man who turns it, takes hold of the

Head

Head of the Harrow with one Hand, and lays the other upon the Hopper, or Spindle, to keep it level, and to prevent either of the fore Wheels from ſtriking againſt the Ground, whilſt the Plough is turning round.

Another Difference there is between the Shape of theſe hinder Funnels from that of the former, to wit, That each fore Side of the hinder Trunks muſt not be quite ſo oblique as the reſt; becauſe then the upper Edge of theſe fore Sides might be too near the Tenons of the Sheats, and there might not be ſufficient Wood betwixt them, to prevent the Sheats from being torn out; a thing which has never happen'd, that I know of. We ſometimes make theſe hinder Funnels of a roundiſh Shape, like a Cone inverted; except that the Part which is next the Sheat, is not ſo oblique as the reſt, for the Reaſon already given.

The only Advantage propoſed by this roundiſh Shape is, that there is leſs Wood taken out than from the ſquare Corners, and therefore more Wood for the added Pieces to be faſtened to the Beams, than in the ſquare Funnels.

M and N are Two Pieces of Wood, each Eleven Inches long, Two Inches broad, and Two Inches thick: Theſe are ſcrew'd on near each End of the Plank, by Two Screws and Nuts each: They ſtand parallel to the other Beams, and have each a double Standard or Fork, O and P, in them, perpendicular to the Plank; by which Standards the fore Hopper is drawn and guided, in the manner as is ſeen in *Fig.* 21.

Theſe Standards ought to be braced (or ſpurr'd) before and behind, and on their Outſides; they never being preſs'd inwards, have no occaſion of Braces there: Theſe are to be ſo placed, that when the Spindle is in their Forks, it may be exactly over the Hole of the Funnel, ſo that the Seed may drop into the Middle of it, when the Plough ſtands upon an horizontal

Surface,

Surface, the Spindle being alſo exactly parallel to the fore Edge of the Plank.

Fig. 10. is D in the Plough *Fig.* 1. It is Two Feet long, Two Inches broad in its narroweſt Part, and half an Inch thick in the thinneſt Part, and Two Inches at its Shoulders above the Plank. It is pinn'd thro' the Plank before the Funnel, having one of its Legs on each Side the Tenon of the Sheat: It ſtands perpendicular to the Plank: Its only Uſe is to hold the fore Hopper from turning upon the Spindle, being put thro' a thing (*Fig.* 22.) like the Carrier of a Latch, nail'd on to the upper Part of the fore Side of the fore Hopper, in which thing this Standard has room to play, or move ſide-ways, to the end that either Wheel may riſe up.

Fig. 11. is one of the hinder Standards, which being placed in the Beam, as G or H, perpendicular to it, is driven into a Mortiſe, and pinn'd into the Beam. It has a Shoulder behind, and another before, and a Third on its Outſide; which Shoulders ſerve inſtead of Braces, to keep it from moving backwards, forwards, or outwards: It is Two Feet Four Inches long, Two Inches broad, and an Inch thick: It is placed with its broad or flat Sides towards the Sides of the Beams. It is made ſo thin, becauſe it ſhould have the more room for the Hopper to play on it; and therefore muſt have its Strength in its Breadth. The Part at *a* muſt ſtand foremoſt.

The Standards G and H are both alike, except as they are oppoſite: Their Uſe is to draw, guide, and hold up the hinder Hopper: They are to be placed perpendicular to the Beams, and at equal Diſtance from each Side of thoſe Beams, and at ſuch a Diſtance before the Funnels, that when the fore Side of the Hopper by its whole Length bears againſt the hinder Surface of the Standards, the Seed may drop into the Middle of both Funnels, the Plough ſtanding upon an horizontal Surface.

Be ſure to take care, that the Sheats, Funnels, and Standards, be ſo placed, that the Spindle of the Hopper may be at right Angles with the Beams.

Q and R are Part of the Limbers, which are alſo called Shafts, Sharps, and Thills; from whence the Horſe that goes in them is call'd a Thiller. Theſe Limbers are ſcrew'd down to the Plank, by Two Screws and Nuts each. The Limbers are kept at their due Diſtance by the Bar S; near each End of which Bar, there is a Staple with a Crook underneath each Limber, to which is hitch'd, or faſtened, a Link of each Trace, for drawing the Plough. This Bar is parallel to the Plank, and Seven Inches and an half before its fore Edge.

The Limbers muſt be mounted higher or lower at their fore Ends, according to the Height of the Horſe that draws in them; and this may be done by the Screws that hold them to the Plank, and by cuting away the Wood at the Two hinder Screws, or at the Two foremoſt Screws, or by Wedges.

Every Workman knows how to team the Limbers; that is, to place them ſo on the Plank, that the Path of the Horſe which goes in the Middle betwixt them, may be parallel to all the Shares, and ſo that a Line, drawn in the Middle of this Path, might fall into a ſtrait Line with the fore Share, ſtanding on the ſame even Surface with the Path; for otherwiſe the Plough will not follow directly after the Horſe, but will incline to one Side.

The Uſe of the Trunks of this Plough is for makeing the Chanels narrow, of whatſoever Depth they are: But, without Trunks, the Chanels muſt be made wide by Ground-wriſts, which ſpread the Sides of the Chanels wide aſunder, to the end that they may lie open for receiving of the Seed; and the deeper they are, the wider they muſt be: By this Width of a Chanel, the Seed in it is with more Difficulty cover'd, and the Chanel fill'd with the largeſt Clods, and the

Seed comes up of a great Breadth, perhaps Three or Four Inches wide, ſo that the Weeds coming therein are hard to be gotten out.

To avoid theſe Inconveniences of wide Chanels, I contrived Trunks like thoſe deſcribed, except that they were but Five or Six Inches high; and the Tops of their Plates, bending outwards from each other, form'd Two Sides of a Funnel; and the Wood between the Two Plates, being cut bevel at the Top, was as the fore Side of a Funnel to this Trunk: It was open behind from Top to Bottom: The Wheels were low, and the Seed-boxes narrow: The Seed in theſe Chanels was eaſily cover'd, eſpecially thoſe Sorts which were ſown in dry Weather; for then the fineſt Mould would run in, and cover the Seed, as ſoon as the Trunks were paſt it.

The Seed in ſuch a narrow Chanel comes up in a Line, where the Row not being above a Quarter of an Inch broad, ſcarce any Weeds come in it; and when the Weather is dry, the Earth of the Chanel not lying open to be dry'd, the Seed comes up the ſooner.

I had Two Reaſons for making of theſe Trunks higher, as they are now uſed: The one was, to avoid the too great Length of the Shares; and my other Reaſon was, that with thoſe low Trunks, and long Shares, there could not be Two Ranks of Shares, and their Hoppers in the Plough, which are neceſſary for making very narrow Partitions, and abſolutely neceſſary for planting this treble Row of Wheat; for if Three Shares for making the Seven-inch Partitions were placed in one Rank, the Mould (which is always moiſt or wet, when we plant Wheat) would be driven before the Shares, there not being room for it to paſs betwixt them.

Fig. 12. is one End of the hinder Hopper laid open. I call it one End (altho' it be an intire Box by itſelf) becauſe this Hopper is ſuppoſed to have its middle Part cut out, to have a clearer Sight of the

Plough,

Plough, and fore Hopper; as is ſeen in *Fig.*15. which is the whole Hopper in Two Parts. In this *Fig.* 12, A is the Inſide of one End of the Hopper, made with ſeveral Pieces of half-inch Elm-board nail'd on to the Poſt *c a*, on the fore Side; which Poſt is a little more than half an Inch ſquare, and Seventeen Inches and Three quarters long, being the Depth of that Part of the Hopper which holds the Seed. B is the fore Side of this Hopper; which muſt be nail'd on to the ſaid Poſt, being of the ſame Length with it, and Four Inches broad, and half an Inch thick; and this is the Part which on its Outſide goes againſt the right-hand Standard of the Plough, when it is at Work. The other Poſt *b d*, of the ſame Thickneſs with the former, is nail'd in within half an Inch of the oppoſite Edge of this End; to which Poſt alſo C being nail'd, makes the hinder Side of this Part of the Hopper. C is Four Inches broad, and half an Inch thick; and both it, and the Poſt to which it is to be nail'd, are ſomething longer than its oppoſite Side, becauſe the Side B makes right Angles with the Top and Bottom of the Hopper; but the hinder Side C makes oblique Angles with the Top and Bottom of the Hopper; and the Reaſon of this is, becauſe when the Hopper is full of Seed, it may be equally pois'd on the Spindle; which it could not be without this Bevel, unleſs the Bottom of the Hopper did come as much behind the Spindle as before it; and that would hinder the Perſon that follows the Drill, from ſeeing the Seed fall out of the Seed-box into the Funnel; and that Part of the Bottom which is before the Spindle, cannot be made ſhorter, becauſe that Part of the Seed-box which is before the Spindle, is (upon account of its Tongue) much longer than the Part of it which is behind the Spindle. 'Tis true that when the Hopper is empty of Seed, it cannot be thus pois'd; but then, being ſo light, it does not require it. *e f g h* is a Piece of a Board, nail'd on to that Part of the End

A, which is below the Bottom of the Cavity which holds the Seed, and is commonly plac'd a little croſs the Grain of the Board to which it is nail'd, and ſerves to ſtrengthen it, and keeps the Hole *i* from ſplitting. The upper Edge *e f* of this added Piece of Board is exactly the Length of the Bottom of the Hopper, whereto the Braſs Seed-box is faſtened; and this Bottom, together with its Seed-box under it, being put into its Place, bears upon this Piece from *e* to *f*, which holds up the right Side of the Bottom, and keeps it from ſinking downwards; as the lower Ends of the Two mention'd Poſts, and the fore and hinder Side B and C nail'd to them, prevent its riſing upwards.

The Manner of making the Hole *i* is as follows: Place the Seed-box with its fore End at *e*, and hinder End at *f*, with the Baſe of its Cylinder (or great Hole) againſt this added Piece of Board, and its upper Edge exactly the Height of the Edge *e f*; then, with a Pair of Compaſſes put thro' the Cylinder of the Seed-box, mark round the inner Edge of its Baſe upon the added Board; then take off the Seed-box, and find the Centre of the mark'd Circle; and then with a Tool call'd a Centre-bit, of the right Size, bore the Hole quite thro' the double Board; and this Hole will be in the right Place, and of the ſame Diameter with the Spindle; but in caſe there is to be a Braſs Wreath on that Part of the Spindle which is to turn in this Hole, then the Hole muſt be bor'd of the ſame Diameter with that Part of the Wreath which is to enter it; and that may be perhaps near a quarter of an Inch longer than the Diameter of the Spindle, upon which it is faſtened.

This End A, thus bor'd and ſhap'd, is a Pattern for its Oppoſite, and for the other Two Oppoſites of the other Cavity, which holds the Seed at the other End of the Hopper.

When the Oppoſite of A (with the Two Poſts, whereto the fore Side B, and the hinder Side C, are nail'd, and having a like Piece of Board in its lower Part with a like Hole in it) is added, and when the Bottom (Four Inches broad), with its Seed-box under it, is thruſt in at *f* by the prick'd Lines, until it reach *e*, bearing on one Side upon the Piece of Board *e f g h*, and the other Edge of the Bottom bearing in like manner upon the oppoſite Piece, then this Cavity of the Hopper, which will contain about Two Gallons of Seeds, will be finiſh'd.

Note, The Bottom muſt make a right Angle with the Two fore Poſts, having the Side B perpendicular to it.

D is a Part of the Board which comes out farther than the Hopper, in order to hold a Bar at *k*; which being faſtened there, and in like manner to the Oppoſite of this Board, this Bar bearing againſt the fore Part of the Standard, the Hopper and its Wheels are in part drawn by it.

Into the Notch *l* is faſtened one End of a long Bar, which paſſes the whole Length of the Hopper, and holds the upper Part of its Two Cavities in their Places, as is ſeen mark'd D, in *Fig.* 15.

E is Part of the Board which comes before the Hopper, and whereto one End of a Piece of Wood is faſtened by Nails or Screws, which bearing againſt the fore Part of the Standard, and againſt its Inſide, the Hopper is in part drawn and guided by it, as ſhall be ſhewn in *Fig.* 15.

Fig. 13. ſhews the Outſide of the Figure laſt-deſcrib'd. A is the Standard by which this End of the Hopper is drawn, in the manner as it is here placed. B is one End of the Spindle paſſing thro' the Hopper and Seed-box. C the Bottom, having the Seed-box faſtened on to it, with one Screw before, and another behind, with their Nuts underneath, and the Heads of their Screws very thin, and the Pins ſquare at

Top, that they may not turn in the Wood; and their Heads muſt either be let into the Wood, even with the Surface, or elſe the Sides B C of the Hopper muſt be cut for theſe Heads of the Screws to paſs in under them.

This bottom Board, which holds the braſs Seed-box, is Four Inches broad, and full half an Inch thick, and at each End a quarter of an Inch longer than the Seed-box: This Piece is firſt thruſt in ſliding upon the Two added Pieces of Board, until its fore End come under the fore Side of the Hopper, and its hinder End under the hinder Side; then ſetting the Hopper with its Bottom upwards, the Spindle being thro' the Seed-box, and Holes of the Hopper, we hold the Seed-box hard upon the Bottom, at equal Diſtance from each End of it, whilſt the Holes are bored thro' the Bottom, by the Holes at each End of the Seed-box; and then the Screws, being put thro', ſcrew on the Box; and when that is done, we make a Mark upon the bottom Board, with the Compaſſes, on each Side of the Braſs Box, beginning from the Ends of the Axis of the Tongue, reaching as far backwards as is the Length of the Mortiſe: Theſe Two Lines or Marks are a Direction for cutting the Hole in the Bottom of the Hopper, thro' which the Seed deſcends into the Seed-box; then we pull out the Spindle, then draw out the Bottom, take off the Seed-box, and cut the Hole in the Bottom in the manner I will now deſcribe in *Fig.* 14, where the Two prick'd Lines *a b* and *c d* are the lower Edges of the Hole, and the ſame with the Two Lines mention'd to be mark'd by the Sides of the Seed-box. The prick'd Line *a d*, being at right Angles with the Two former, is the lower Edge of the fore End of the Hole, and exactly over the Axis of the Tongue, and parallel to it. The prick'd Line *b c* is the lower Edge of the hinder End of the Hole, which is juſt over the hinder End of the Mortiſe, and parallel and equal to the laſt-mention'd prick'd Line: TheſeFour prick'd Lines are the lower Edges of this Hole, contiguous to the Seed-box. The Two Lines *e f* and *g h* are the upper Edges of the Sides of the Hole, which, being farther aſunder than the lower Edges, make the reverſe Bevel of this Hole; which may be determined by this, that the Surface between theſe Two upper and lower Edges, being Planes, are inclin'd to one another downwards, in an Angle of about One hundred and Thirty Degrees. The Two Lines *e h* and *f g*, at right Angles with the Two laſt-mention'd Lines, make the upper Edges of the Ends of this Hole; and, being nearer together than the prick'd Lines under them, the plane Surfaces, betwixt theſe Two Lines and thoſe Two prick'd Lines, ſhew the Bevel of the Ends of theſe, which are inclin'd to each other upwards, in an Angle of about Sixty-five Degrees.

This double Bevel effectually prevents the Seed from arching in the Hole, before it gets into the Mortiſe of the Seed-box; and alſo, the Two upper Edges of the Ends of the Hole being nearer together than the lower, there is the more Wood left between theſe Edges and the Screws, which hold the Box to the Bottom, whereby the Board is leſs apt to ſplit.

Then the Box being ſcrew'd on to the Bottom, and thruſt again into its Place, the Spindle, paſſing thro' both the Hopper and the Box, keeps the Bottom in its Place: Then D, in *Fig.* 13. is the imaginary Plane of the Top or Mouth of the Hopper, being a rectangled Parallelogram, and parallel to the Bottom, to which the fore End is perpendicular, and a rectangled Parallelogram of the ſame Breadth.

Fig. 15. ſhews the fore Side of the whole hinder Hopper, with its Two Cavities, and all its Accoutrements, except the Wheels; the Two Ends A and B being exactly alike, having each of them its Seed-box at the Bottom, in the ſame manner as in the one has been deſcribed. The Bar D holds together the upper

Parts of this double Hopper at a right Diſtance, which is, when there is Ten Inches clear room betwixt the Two ſingle ones. The Spindle E, paſſing thro' the Whole, holds the Two ſingle Hoppers by Four Wreaths, at the ſame Diſtance below, as they are held by the Bar above.

Theſe Four Wreaths are ſcrew'd on to the Spindle, to keep it from moving towards either End, as well as to hold the Hoppers in their Places: Two of which Wreaths are ſeen at *a* and *b*; and the other Two are placed on the Outſides, as theſe Two are on the Inſides. Before we proceed any farther in this Figure, it will be proper to ſhew the Wreaths, which are of Two Sorts.

The one in *Fig.* 16. where A is its Hollow, which is circular, and muſt be of the ſame Diameter with the Spindle; and, being thruſt on upon the Spindle, till it touch the Board, is faſtened to the Spindle by a ſmall Screw thro' each of its oppoſite Holes. *a b* ſhews the Breadth of this Wreath, whether it be made of Braſs or Wood: It is little more than half an Inch. *b c d* is the Part of it that goes againſt the Board: The Thickneſs of the Surface of this End which goes againſt the Board, is a quarter of an Inch, if made with Braſs; but if with Wood, half an Inch; but the Thickneſs of its other End *a e f* is leſs than its End *b c d*, by which means the Screws are the more eaſily turned in.

Fig. 17. ſhews the other Sort of Wreath, which is always made in Braſs: Its Cavity is a hollow Cylinder like the former: When it is on the Spindle, its End *a b c* is thruſt into the Hole of the Board (made wider for the Purpoſe) until *d e f* come cloſe to the Board, and ſtop it from entering any farther; then we ſcrew it on to the Spindle by the Holes, as the other Sort of Wreath is deſcrib'd to be ſcrew'd.

This is the beſt Sort of Wreath; becauſe it keeps the Spindle from wearing againſt the Edges of the

Hole, and then the Spindle never has any Friction againſt the Wood in any Part of it; but the other Sort are more eaſily made (eſpecially of Wood), and the Spindle will laſt a great while in them; or if it be worn out, the Expence of Three-pence or Four-pence will purchaſe a new Spindle.

Now I muſt return to *Fig.* 15. where the Spindle E having its Four Wreaths fixt on it, we turn it round with our Hand, to ſee whether the Wreaths are put on true; and when they are ſo, neither the Spindle, nor the Hoppers, can move end-ways: Tho' the Spindle be pretty hard to turn round, the Wheels will ſoon cauſe it to turn eaſily. Whilſt the Spindle is in this Poſture, we turn the Hopper Bottom upwards, and mark the Spindle for cutting the Notches in the manner before directed; and then we take off the Spindle, and cut the Notches, and alſo cut each End of the Spindle ſquare, up to a Shoulder at each End, ſo that the Wheels may come eaſily on without knocking or thruſting; and then we return the Spindle to its Place, and put on the Wheels, pinning them on with each a long Nail, which being crook'd at the Ends prevents it from falling out, but may be very eaſily pull'd out with the Claws of a Hammer; but we muſt take care, that neither the ſquare Ends of the Spindle, nor the ſquare Holes in the Naves (or Hubs) of the Wheels (into which they enter), be taper; for, if they are taper, the Wheels will be apt to work themſelves off.

The Piece of Wood, *Fig.* 18. is that which goes over the Standard, and, being plac'd in the Hopper, as F in *Fig.* 15. draws that Part of the Hopper by its Inſide *a b* bearing againſt the fore Part of the Standard; and that Part of it from *b* to *c*, being the Breadth of the Standard, bears againſt its inner Inſide, to prevent the Hopper from going any farther towards that End. This Piece of Wood is faſtened to the Boards of the Hopper, either by Screws or Nails:

This Piece, from *d* to *e*, muſt be of ſuch a Thickneſs, that the Standard, bearing againſt its Inſide *b c*, may be equidiſtant from each Board, to which this Piece is faſtened. The Part, or fore Side of this Piece *f g*, muſt be the Length of the Diſtance between Board and Board, to which it is faſtened; and that is exactly Four Inches. Its Thickneſs and Depth muſt be ſuch as may make it ſtrong enough for the Purpoſes intended.

The Piece mark'd *Fig.* 19. is the Oppoſite of the former, and to be placed in the ſame manner, and as it is ſeen mark'd G in *Fig.* 15. obſerving always, that the Part of it, which holds the Hopper from moving end-ways, muſt always be on the Inſide of the Standard; for, if theſe Pieces ſhould bear againſt the Outſides of the Standards, the Hopper could have no Play upon them, nor could either of the Wheels riſe up without raiſing the Share (that was next to it) out of the Ground; but, being thus placed, either Wheel may riſe without the other, and without raiſing the Share.

I ſay more of this, becauſe it is a Point wherein young Workmen are apt to miſtake.

Thus having ſhewn, in *Fig.* 15. how the Hopper is guided and drawn at the lower Part, I come next to ſhew how it is held and drawn at its upper Part; for which the Piece of Wood, *Fig.* 20. being a competent Breadth and Thickneſs, Four Inches long, is fix'd in betwixt the Boards with Nails or Screws; and is H in *Fig.* 15. The Standard paſſing up betwixt this and the fore Side of the Hopper, its fore Surface bearing againſt this Bar, and its hinder Surface againſt the Hopper; ſo that the Hopper may riſe and ſink eaſily upon the Standard at Top, being in the Middle on the fore Side of the Hopper; there will be an equal Diſtance of each Side, for either Wheel to riſe, without the Standard ſtriking againſt the Sides of the Hopper to hinder its riſing. There is another Bar equal to this, and has the ſame Office, at the other End of the Hopper, mark'd I. Likewiſe the Bar D is of the ſame Uſe with theſe mention'd ſhort Bars, and they help to ſtrengthen one another.

When the Wheels are put on till they reach near to the Wreaths, they will ſtand with their Rings, or Circles, Two Feet Three Inches aſunder.

We ſet them as near together as conveniently we can; becauſe when they are too wide, they are apt to draw the Plough towards one Side of the Ridge; and ſometimes, when the Ridge is high, the Hopper might bear upon the Funnels; and then the Wheels, being carried above the Ground, would not turn to bring out the Seed: And that theſe Wheels may come the nearer together, their Spokes are ſet almoſt perpendicular; ſo that the Wheels are not concave, as other Wheels are. This Hopper is ſhewn, put on upon its Standards, in its Place, in *Fig.* 21. where the mention'd Bar D, which holds the Hopper together at Top, is ſeen, as alſo the Four Wreaths, and likewiſe the hinder End of the Seed-boxes ſtanding over the Funnels, with their Trunks underneath them. Here alſo the back Part of the fore Hopper is ſeen, with its Seed-box ſtanding over the fore Funnel: Its Mouth alſo is ſeen at A; as alſo the Top of its fore Side held up by the thing (*Fig.* 22.) like the Carrier of a Latch, with the Nails in it, which faſten it to the Top of the fore Side of the Hopper, and give room for either of its Wheels to riſe.

This fore Hopper may be eaſily deſcrib'd by the Figure of a Box, like the other already deſcrib'd, at its Ends, which are of the ſame Shape with the Inſide of the Box, *Fig.* 12. but much lower, being Seven Inches and an half deep, and Sixteen Inches long; and the Breadth of its Bottom is determin'd by the Length of the Seed-box, and a little wider at Top, on account of the Bevel which poiſes it: It carries no more Seed than one End of the hinder Hopper;

but it is capable of holding more; but we do not fill it quite, leſt ſome of the Seed ſhould fly over in jolting, its Mouth being ſo much longer than of the other.

This Hopper is kept in its Place, from moving end-ways upon the Spindle, by a Wreath fix'd to the Spindle at each End of the Box, in the ſame manner as has been deſcrib'd for holding the other Hopper. The Wreaths moſt proper for this Purpoſe are the Sort deſcribed in *Fig.* 17. but the other Sort deſcribed in *Fig.* 16. and even made with Wood, will ſuffice; but then we muſt take care to make the Hole at the End of the Hopper of a conſiderable Thickneſs, that it may not wear the Spindle, which, by reaſon of its great Length, is the more liable to bend, and be cut by the Edges of the Holes; which Cutting cannot be prevented but by the Thickneſs of the Holes, or by ſuch Wreaths as that of *Fig.* 17.

We ſometimes make this Hopper exactly like a common Box, without any Part of its Ends deſcending below the Bottom; and, in that Caſe, we place a narrower Piece of Board at each End of the Hopper, like that of *Fig.* 23. in which Figure, the Hole A being put on upon the Spindle, the Piece of Board is faſtened on by a Screw and Nut thro' the Hole B, near the Top of the End of the Hopper, and by another Screw and Nut thro' the Hole C, near the Bottom of the Hopper. Another ſuch a Piece of Board, fix'd on in the ſame manner to the oppoſite End of the Hopper, holds this long Hopper parallel to its Spindle, that paſſes thro' the Holes of theſe Two Pieces, and thro' the Braſs Seed-box, which is fix'd up to the Bottom, in the Middle betwixt them.

There are Two Methods for letting the Seed paſs from a long Hopper into the Seed-box. The firſt is that of cutting the Hole thro' its Bottom, in the manner that has been ſhewn in *Fig.* 14. The other is that which cannot be uſed in a Hopper ſo ſhort as the Boxes of our hinder Hoppers are; but in the fore Hopper, or any other long Hopper, we can place the Braſs Seed-box to a Bottom made for the Purpoſe, like that in *Fig.* 24. where there is a Piece of Board on the fore Part of the Hopper from End to End, as *a b*, and another on the hinder Part of the Hopper, as *c d*. Then the fore Part of the Braſs Seed-box, being placed under the Piece *a b*, is ſcrew'd up to it at *e*, and the hinder Part of the Seed-box under *c d* ſcrew'd up to it at *f*; then the Bottom of the Hopper, being open in the Middle, is ſhut by very thin Boards, *g* and *h*, fix'd up to the mention'd Pieces: Theſe Boards having their upper Surface even with the upper Edges of the Braſs Box, the Seed can no way arch in coming into the Mortiſe of the Seed-box. Whichever of theſe Two Methods be made uſe of, in a long Hopper, the Bottom muſt be fix'd to the Two Sides, by ſmall Bars of Wood of about Three quarters of an Inch ſquare, to which the Bottom and Sides are faſtened by Nails, in the manner that the Ends and Sides of the hinder Hopper are faſtened to their Poſts, which ſtand in their Corners.

We take the ſame Method for cutting the Notches in this Spindle, as has been deſcribed for cutting the Notches in the other Spindle.

But obſerve, That the great Length of this Spindle requires it to be the larger; and we make it of an Inch and Three quarters Diameter, the other being only an Inch and an half: We therefore bore the great Hole or Cylinder of its Braſs Seed-box a quarter of an Inch in Diameter larger than of the braſs Seed-boxes of the hinder Hoppers; and we commonly make a Notch more in the Circumference of this Spindle, becauſe the Semidiameters of its Wheels muſt be as much greater than of the hinder Wheels, as is the Thickneſs of the Plank, and the Ends of the Limbers which are betwixt this Spindle and the upper Surface of the Two Beams.

We make all our Spindles of clear-quarter'd Aſh, without Knots or Crooks; and when they are well dry'd, and made perfectly round, and of equal Diameter from one End to the other, by the Prong-maker, we pay a Peny *per* Foot for them at the firſt Hand, and they will now-and-then have ſomething more for the largeſt Size; but we are only curious to have the middle Part of this long Spindle exact; for we graft on a Piece at each End, which does not require any Exactneſs: The Graftings are ſeen at *a a* at one End, and *b b* at the other End of the Spindle (in this *Fig.* 21.) by Four flattiſh Iron Rings driven on upon the grafted Parts, as they appear under thoſe Letters in the Middle. Between each Pair of theſe Rings, we drive a ſmall Iron Pin thro' the Joints at *c* and at *d*, to keep the Grafts from ſeparating end-ways; and if they are not tight enough, we make them ſo, by Wedges driven in betwixt them and the Spindle.

This fore Hopper is drawn by the Spindle, and the Spindle is drawn by the Two double Standards B and C, betwixt whoſe Forks it is placed, as appears in this Figure; the Diſtance between each Fork, or double Standard, being exactly the Diameter of the Spindle, ſo that the Spindle may have juſt room to riſe and ſink there, and no more.

The Hopper and Spindle are guided, or kept in their Place, from moving end-ways, by Two Wreaths ſcrew'd on to the Spindle, the one at *e*, and the other at *f*; each of which Wreaths, bearing againſt the Surfaces of both the Legs of each double Standard, on the Sides next to the Hopper, prevent the Spindle and Hopper from moving towards either End; and yet admit the Wheels, or either of them, to riſe and ſink without raiſing either Side of the Plough, contrary to what would happen, if the Wreaths were placed on the Outſides of the Standards next to the Wheels.

We make theſe Wreaths a little different from the other Sort of Wreaths, which turn againſt the Holes; we make them of a greater Diameter, leſt they ſhould at any time get in betwixt the Legs of the double Standards, in caſe the Standards ſhould be looſe, or bend: Therefore we make the Diameter of each of theſe Wreaths, at leaſt, Two Inches and Three quarters: We always make them of Wood, and of a peculiar Shape, taking off their Edges next the Standards, which Edges would be an Impediment to the Riſing of one End of the Spindle without the other. So that, for making theſe Wreaths, we may form a Piece of Wood of the Shape of a Skittle-bowl (or an oblate Spheroid) having an Inch and Three-quarter Hole bor'd thro' its Middle, and then cut by its Diameter (which is about Three Inches) in Two Halves, each of which will be one of theſe Wreaths; and they muſt be placed on the Spindle, with their convex Sides bearing againſt their reſpective Standards.

The Diameter of the fore Wheels is about Thirty Inches, as the Diameter of the hinder Wheels is about Twenty-two.

The fore Spindle ſhould be of ſuch a Length, that its ſquare Ends, E and F, may come out Three or Four Inches farther than the Hubs (or Stocks) of the Wheels; ſo that there may be room to ſhift the Wheels towards either End, for making ſeveral Sets of Notches, for the Uſe of the Seed-box.

Obſerve, Tho' the fore Hopper is drawn by its Spindle, yet the hinder Spindle is drawn by its Hopper.

The Reaſon of this great Diſtance between the Two fore Wheels is not ſo much for their ſerving as Marking-wheels to this particular Drill; which being drawn only upon a Ridge, its Top is a ſufficient Direction for leading the Horſe to keep the Rows parallel to one another, if the Ridges are ſo; but if the Wheels were much nearer together than they are, and yet more than Six Feet aſunder, the Wheels going on the Sides of the next Ridges would be apt to turn the Drill out of the Horſe-path towards one Side, not permitting the Drill to follow directly after the Horſe; and if the Wheels ſhould ſtand at Six or Seven Feet Diſtance from one another, then they muſt go in the Furrows which are on each Side of the Six-feet Ridge: This would occaſion their Hopper to bear upon the Plank, which would carry the Wheels above the Ground, and no Seed would be turned out of the Hopper, unleſs the Wheels were of an extraordinary Height *(a)*; and the Height requir'd for them would be very uncertain, ſome Furrows being much deeper than others; but the Tops of contiguous Ridges are generally of an equal Height, whether the Furrows betwixt them be deep or ſhallow; for we ſeldom make Ridges of an unequal Height in the ſame Field: Therefore there can be no need to change the Height of our Wheels, that are to go upon the Middle of the Ridges; but if they went in the Furrows, they muſt be of a different Height

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(*a*) Notwithſtanding the Reaſons given, and that I have never uſed Wheels of ſuch an Height as might be neceſſary for going in the Furrows; yet it may not be amiſs to try ſuch; becauſe with them the Spindle needeth not to be more than half the Length of one that is carried by low Wheels: And high Wheels will allow the Funnel to be much larger, ſo that altho' the Spindle go higher from it, no Seed will drop beſide a large Funnel; but there is not room for a large one under low Wheels.

I did not think it neceſſary to deſcribe the Manner of making Drill-wheels any otherways than by ſhewing them in the *Plates*; but I will obſerve here, that they are to be made very light: One of mine, that is 30 Inches high, weighs Five Pounds and an half; it has a Circle or Ring of Iron, whoſe Depth is half an Inch, and its Thickneſs a quarter of an Inch; alſo very thin Iron Stock-bands to hold the Nave or Stock from ſplitting. The Circle is held on the Spokes by ſmall flat Iron Pins on each Side; and each Spoke has a Ring of Iron to ſecure its End from being ſplit by driving in of the Pins. We alſo make the Drill-wheels leſs concave than other Wheels are.

when uſed for drilling of high Ridges, from what would be required when uſed for drilling low Ridges.

One Reaſon why the hinder Shares are ſhorter than the fore Share (and conſequently the fore Part of their Sheats leſs oblique) is, that they may be ſet the nearer to the Plank; and I have had a Drill with Five Shares in the Plank, Fourteen Inches aſunder, and Four of theſe hinder Sheats following in another Rank, whoſe Shares were leſs than Three Inches long; ſo that their Beams were ſet ſo far forwards, that one Hopper (by a Contrivance, that carried the Seed forwards to the fore Rank, and backwards to the other Rank) ſupply'd the Seed to both Ranks of Trunks, and planted St. Foin in Rows Seven Inches aſunder, when the Ground was too rough to be planted with Rows at that Diſtance by one Rank of Shares.

It may be objected, that the fore Part of theſe hinder Sheats might not be oblique enough to raiſe up the Strings of Roots or Stubble, which might come acroſs them in their Way; but this Inconvenience is remedied by the greater Obliquity of the fore Sheat (or Sheats), which clears the Way for the hinder Sheats, by raiſing out of the Ground ſuch Strings, &c. which might annoy them; eſpecially, in this Wheat-drill, where the fore Share ſo clears the way of the hinder Shares, that they can take hold of no String in the Ground, except of the Ends of ſuch which the fore Share has looſen'd; and they hanging faſter in the Ground by their other Ends, the hinder Shares ſlip by them without taking hold of them; and the Harrow-tines, going after ſo near to the Chanels of the hinder Sheats, by the ſame means eſcape alſo from hanging in ſuch Strings.

The Reaſons for placing the One Share and One Hopper before, and the Two behind, in this Wheat-drill, are ſo many, and ſo obvious, that it would be but loſing of Time to mention them.

The Limbers G and H, we make of Aſpen, Poplar, or Willow, for Lightneſs; we make them as ſmall and light as we can, allowing them convenient Strength; and the ſhorter they are, the more exactly the Drill will follow the Horſe, without the Hand of him that follows the Drill, whoſe chief Buſineſs is, with a Paddle to keep all the Shares and Tines from being clogged up by the Dirt ſticking to them, and alſo to obſerve whether the Seed be delivered equally and juſtly to all the Chanels.

Theſe Limbers ſhould approach ſo near together at their fore Parts, near the Chain, that there may be none or very little room betwixt the Limbers and the Horſe; and therefore muſt be nearer together for a very little Horſe than for a great one: The Horſe, which I have uſed in all my Drills for theſe many Years paſt, is a little one, about Thirteen Hands high; and the fore Part of my Drill-limbers are Twenty Inches wide aſunder at the Chain.

At *g* on the Outſide of the Limber G, is a ſmall Staple driven in, having one Link on it, which holds a ſmall Hook, which, taking hold of different Links of the very ſmall Chain I, raiſes or ſinks the fore Part of the Plough to different Heights. But take care to ſet it at ſuch a Degree, that the fore and hinder Share may go equally deep in the Ground; and when they do ſo, the fore Part of the Limbers ought to be higher than the Traces which draw them.

At *h* in the Limber H, is driven another Staple, which holds the other End of the Chain; or elſe, inſtead of a Chain, we may make uſe of a Piece of Cord, one End of which put thro' this Staple, and ty'd to the Limber, and a Piece of Chain of half a dozen Links, faſten'd to the other End of ſuch a Cord, will ſerve as well as a whole Chain, for raiſing and ſinking the Limbers.

He who can by theſe Directions make this Wheat-drill, may very eaſily make any other Sort of Drill, for planting any Sort of Corn, or other Seeds that are near about the Bigneſs of Seeds of Corn: He may make it with a ſingle Row of Sheats, by placing as many of theſe fore Sheats as he pleaſes in the Plank, which may be longer or ſhorter, as he thinks fit; and he may add a Beam betwixt every Two of them, with a Sheat in it, like theſe hinder Sheats; and then the Drill will be double, having Two Ranks of Shares. But I muſt adviſe him never to make a Drill with more Shares than will be contain'd in Four Feet Breadth, that is, from the outermoſt on the right Hand, to the outermoſt on the left Hand; for ſhould the Drill be broader, ſome of the Shares might paſs over hollow Places of the Ground without reaching them, and then the Seed falling on the Ground would be uncover'd in ſuch low Places.

To a Drill that plants upon the Level, Marking-wheels are neceſſary, to the end that every Row may be at its due Diſtance: As in a Drill with Five Shares, for planting Rows Eight Inches aſunder, Four of the Five cannot err, becauſe Four equal Spaces are included betwixt the Five Shares; but the Fifth (which we call the parting Space) being on the Outſide unconfin'd, would ſcarce ever be equal, were it not kept equal by the Help of the Marking-wheels. The Rule for ſetting of theſe is thus: We compute altogether the Five Spaces belonging to the Five Rows; which being in all Forty Inches, we ſet the Marking-wheels Eighty Inches aſunder, that is, double the Diſtance of all the Spaces, each Wheel being equidiſtant to the Middle of the Drill, which Middle being exactly over the Horſe-path, when the Drill is turn'd, the Horſe goes back upon the Track of one of theſe Wheels, making his Path exactly Forty Inches diſtant from his laſt Path: By this means alſo the Rows of the whole Field may be kept equidiſtant, and parallel to one another; ſo that it would be difficult for an Eye to diſtinguiſh the parting Rows from the reſt.

But when Two different Sorts of Seed are planted, ſuppoſe a Row of St. Foin betwixt every Row of Barley, the Rows of which being Eight Inches aſunder, and the Barley drill'd by the fore Hopper into the Chanels made by the five Shares, and the St. Foin drill'd from the hinder Hopper into the Chanels made by Six Shares, the Marking-wheels muſt be at no greater Diſtance than thoſe above-mention'd, where there are only Five Shares; becauſe one of the Six, which are for the St. Foin, muſt always return in the ſame Chanel, going twice therein; for One Row of Barley would be miſſing, in caſe the parting Space ſhould be made by this Sixth Share; and that parting Space would have no Barley in it. Therefore it is a Rule, that whenſoever Two Sorts of Seeds are drill'd, the Rows of one Sort betwixt the Rows of the other, there muſt be an odd Share in the Drill, which muſt go twice in one Chanel, and the Diſtance of the Marking-wheels muſt be accounted from that Rank of Shares which are the feweſt: It muſt alſo be contriv'd in this Caſe, that each outermoſt Seed-box muſt deliver but half the Quantity of Seed that each of the inner Seed-boxes do; becauſe the outer ones going twice in a Place, their Chanels would otherwiſe have a Quantity of Seed double to the reſt.

In a Drill that has Two Spindles, we place the Marking-wheels on the foremoſt, which upon their Account is the longeſt; but if we ſhould uſe the Wheels of the hinder Spindle as Marking-wheels, then that muſt be the longeſt, and ſo the fore Wheels (their Semidiameters being much longer than the Semidiameters of the hinder Wheels, and their Spindles ſhorter) would ſtrike againſt the hinder Spindle, unleſs it were ſet farther back than is convenient.

When Ground is harrow'd the laſt time before it is to be drill'd, we contrive that the Harrows may not go directly towards the ſame Point that the Drill is to go, leſt the Track of the Marking-wheel ſhould be exactly parallel with the Track of the Harrow-tines, which might make it difficult to diſtinguiſh the Track of the Wheel from that of the Harrow-tine.

He that has not a great Quantity of Ground to plant with St. Foin, and does not plant it betwixt Rows of Corn, will have occaſion for no other Drill than this Wheat-drill, deſcrib'd in *Fig.* 21. He may plant his Rows at Fifteen Inches aſunder, by the hinder Hopper, and its Shares, without removing them, the fore Hopper being taken off; or elſe you may plant Three Rows at Sixteen Inches aſunder, by ſetting the Beams, and their Seed-boxes and Hoppers, at Thirty Two Inches aſunder inſtead of Fifteen, equidiſtant from the fore Share; and then the Marking-wheels, which are thoſe of the fore Spindle, muſt be Eight Feet aſunder; to wit, double to the Spaces of the Three Shares, which are Three times Sixteen Inches (or Four Feet); or you may ſet the Two hinder Beams, *&c.* at what Diſtance you pleaſe, ſetting the Marking-wheels to correſpond with them; but then the Harrow muſt be alter'd, and both its Legs and Tines muſt change their Places in the Head, the Legs for guiding it exactly, and the Tines to follow in all the Three Rows, which will require a third Tine to be added in the Middle, between the other Two. But without any other Alteration than that of taking off the fore Hopper, and that of leſſening the Seed-paſſages of the hinder Hopper by the Setting-ſcrews; my Man planted me ſeveral Acres of St. Foin with my Wheat-drill Two Years ago, the Rows being all Fourteen Inches aſunder: It is now an extraordinary good Crop.

In caſe the Shares, being only Three, ſhould in fine Ground go ſo deep as to endanger the Burying of the Seed, the beſt Remedy to prevent this fatal Misfortune is, to place a triangular Piece of Wood, like thoſe in *Figures* 25. and 26. the firſt of which ſhews one Side thereof, with the Nail by which it is to be nail'd into the lower Part of the Trunk, with its moſt acute Angle uppermoſt; the other in *Fig.* 26. ſhews the ſame, and its Back-ſide *a b*, that is to be nail'd to the Back of the Sheat, being of the ſame Breadth with it; its Bottom *b c* being the Breadth of the Plates, on their Inſide, the Angle *c* coming out backwards, juſt as far as the Plates: The Depth of this Piece from *a* to *c* is uncertain, becauſe the Plates of ſome Trunks are broader than of others. The Uſe of this Piece is, to fill up the lower Part of the Trunk; ſo that the Seed, dropping upon the oblique Side of this Piece of Wood, may by it be turn'd into the Chanel, after ſo much Mould is fallen in it, as will ſufficiently leſſen its Depth, whereby the Danger of burying the Seed is avoided: And ſuch a Piece of Wood placed into each Trunk, I think, is preferable to Ground-wriſts, which are commonly uſed for this Purpoſe; becauſe the Ground-wriſts leave the Chanels too wide and open.

But when only the Two hinder Sheats are uſed for St. Foin, we can make their Chanels the ſhallower, by ſinking the Limbers by their Chain, ſo much as that, the Plough bearing moſt upon the fore Share, the hinder Shares will go the ſhallower.

When we drill hilly Ground, both up and down, we cover the hinder Parts of all the Trunks, from their Tops, to within Two or Three Inches of the Ground, to prevent the Seed's falling out far behind the Trunk, in going up Hill; and this we do either by a Piece of Leather nail'd to each Side of a Sheat, the Middle of the Leather bearing againſt the hinder Part of the Plates (or Trunk); or ſometimes, inſtead of Leather, we uſe Tin.

Every Trunk being thus inclos'd behind, we can drill up and down an hill of a moderate Aſcent; but when it is very ſteep, we never drill any thing but St. Foin on it, and that by a Drill made for the Purpoſe, ſo very light, that a Man may carry it up the

Hill on his Back, and draw it down after him: This Drill has Five or Six Sheats in one Row (with the Harrow behind them). Their Shares being extremely ſhort, the Standards which draw the Hopper muſt be ſet perpendicular to the Horizon, when the Drill is coming down, rather than to the Surface of the Side of the Hill: The Funnels muſt alſo correſpond with the Standards.

Some, inſtead of theſe Sheats, make uſe of hollow wooden Harrow-tines, thro' which the Seed deſcends: But theſe I do not approve of; becauſe where the Ground is hard, and not fine, they riſe up, and make no Chanels for the Seed; and then it lying uncover'd will be malted.

When a Drill has only one Rank of Shares, we ſcrew on the Harrow by its Legs, to the Inſide of the Two outſide Sheats, as near as we can to their fore Shoulders, leaving ſufficient room for the Harrow to riſe and ſink, in the ſame manner as when it is drawn by the Beams.

CHAP. XXII.

Of the Turnep-Drill.

PLATE 5. ſhews the whole Mounting of a Turnep-drill. *Fig.* 1. is a Plough, but little differing from the Drill-plough laſt-mentioned. A, A, are the Two Limbers, differing in nothing from the other, except that they are lighter, not being above Two Inches Diameter, behind the Bar: They are drawn in the ſame manner as the other. Their Bar B is diſtant from the Plank Three Inches, being ſhoulder'd at each End, with a very thin flat Tenon, paſſing thro' each Limber, and pinn'd on their Outſides, as at *a a*. We do not pin in this Bar thro' the Limbers, leſt the Holes

Plate IV

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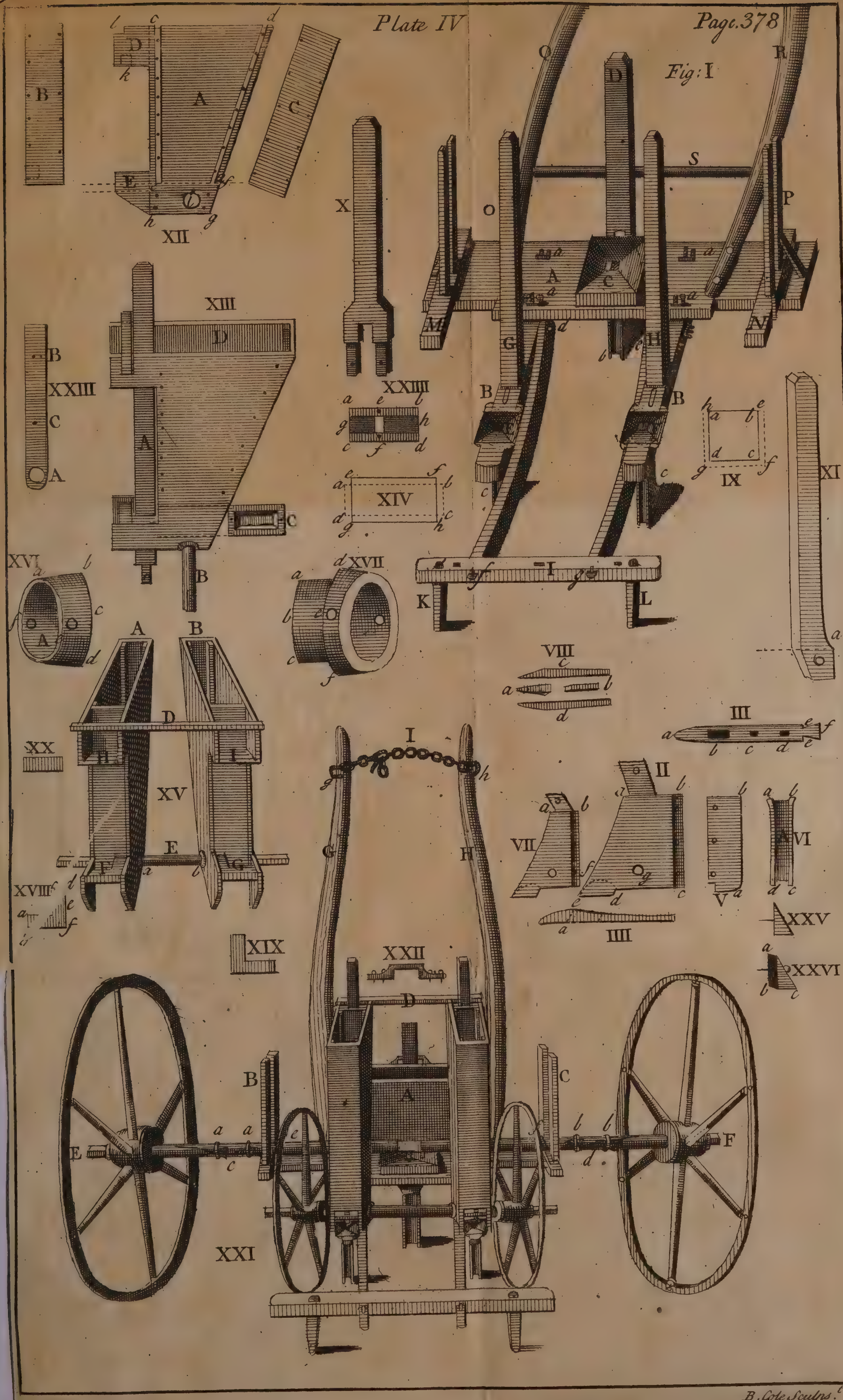

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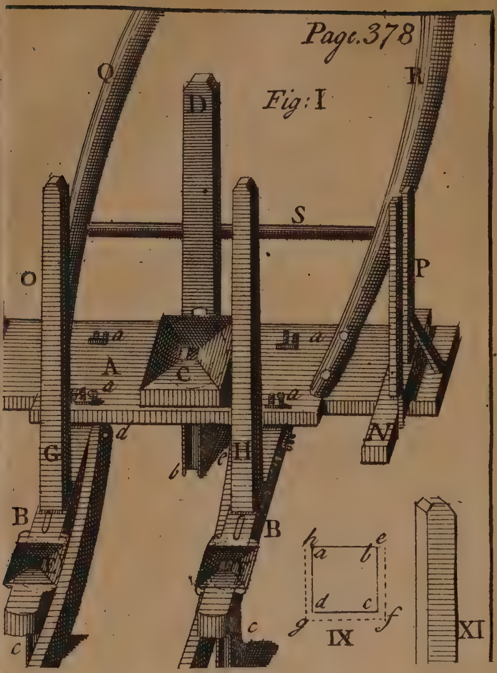


Fig: I

Holes ſhould make theſe very ſmall Limbers the weaker in that Part. C, the Plank, Two Feet and an Inch long, Five Inches broad, and an Inch and a quarter thick. D, D, the Two double Standards, or Two Pair of Standards, placed into the Plank with Shoulders above, and Tenons pinn'd underneath the Plank, and are Thirteen Inches high above it: Theſe ſerve for a Pair of Marking-wheels, when Turneps are drill'd on the Level, to keep the Rows all parallel, and at what Diſtance you pleaſe, by ſetting them according to the Rule already laid down.

Sometimes we place the double Standards into the Plank of the Wheat-drill, in the ſame manner that theſe are placed.

We take off the inner Edge of each Standard at the Top, as at *b b* and *b b*, for the more eaſy Admiſſion of the Spindle of the Marking-wheels into the Forks: This Spindle is kept in its Place by Two of the ſame ſort of Wreaths, and placed in the ſame manner as thoſe deſcrib'd for the fore Hopper of the Wheat-drill.

Such Marking-wheels are neceſſary for drilling upon the Level; but not for drilling upon Ridges.

E is the Beam, Two Feet Two Inches and an half long, Four Inches broad, and Two Inches thick: It is thus broad, that the Screws which hold on the croſs Piece F, may be farther aſunder: The Screws muſt be placed as near as may be to the Outſides of the Beam, and at equal Diſtance from each Side of the croſs Piece; by which means the Standards are kept the firmer from Turning.

The Diſtance between the Plank and the croſs Piece is Eleven Inches. The Breadth of the croſs Piece is Two Inches and a quarter. This croſs Piece is ſhewn apart in *Fig.* 2. where its Two Standards A, B, are each Seventeen Inches long (or high), and each on its fore Side and hinder Side One Inch and a quarter broad, and nearly Three quarters of an Inch thick: They are ſhoulder'd and pinn'd into the croſs Piece at *a b*. The croſs Piece is Thirteen Inches and an half long, and one Inch and a quarter thick in the Middle from *c* to *d*; but for about an Inch on the Inſide of each Standard is Two Inches and an half thick, that the Standards may have the more Wood to ſupport them, and that the Hopper, bearing upon the thicker Parts of the croſs Piece, may be held up above the Funnel, that the Fork of the braſs Spindle may not ſtrike againſt it, when the Plough is taken up to be turn'd, there being a little more than a quarter of an Inch of the Breadth of the croſs Piece behind the Standard, for the Hopper to reſt on.

The whole Diſtance between the Standards is Nine Inches and a quarter. The Standards muſt be exactly perpendicular to their croſs Piece: Their Tops are drawn up each to a Point, as at *e* and *f*, by which the Hopper is the more eaſily put on upon them.

The Funnel, Sheat, Share, and Trunk, are the ſame as thoſe in the Wheat drill, except a few Differences: As G in *Fig.* 1. is the ſame as the fore Sheat of the Wheat-drill, with its Accoutrements; only it is lower, being but Eight Inches high from the Bottom of the Share up to the Beam; and the Plates of the Trunk are ſomewhat narrower: Its Tenon paſſes thro' the Beam, and comes up above it, betwixt the Funnel and the croſs Piece; and there is pinn'd in thro' its Hole above the Beam. There is no want of Wood behind the Sheat, the Funnel not being cut in the Beam, but placed upon it.

The Funnel is ſhewn apart in *Fig.* 3. and is Two Inches deep, Four Inches ſquare at Top; its Four Sides terminating at an Hole in the Bottom, half an Inch broad from *a* to *b*, and near an Inch long from *c* to *d*; which Length is divided in the Middle, by the upper Edge of a Braſs Spout, which divides the Hole into Two equal Parts (or Holes), each of which is about half an Inch ſquare; this Funnel being ſcrew'd on upon the Beam by Two Wood Screws, entering at Two oppoſite Corners of the Funnel, as at *c d* in *Fig.* 1. ſo that the Seed may drop from the Seed-box upon the right Side of the Funnel at *e*, which being about half an Inch diſtant from the Partition, and equidiſtant from both Holes, the Seed rebounding is pretty equally diſtributed to each of the Holes.

The fore Part of the foremoſt Hole being equal with the Back of the Sheat, the Beam being cut thro'; ſo that the Back of the Sheat, and the fore Part of the Hole thro' the Beam, and the fore Part of this Hole, make one plain Surface, whereby the Seed, that falls into this foremoſt Hole, deſcends to the Ground, near the Back of the Sheat, thro' the Trunk.

And the Seed which falls into the hinder Hole, is convey'd obliquely backwards thro' Part of the Beam, by a ſhort thin Braſs Spout, whoſe Diameter in the Inſide is ſomewhat more than half an Inch; but the fore Part of it, which divides the Two Holes, deſcends firſt perpendicularly half an Inch, and then turns off backwards, and there the Spout begins to be round: Its joining is on its hinder Part, to the end that the Seed, never running upon it, cannot be ſtopp'd by it. The lower End of this Spout ends at the lower Surface of the Beam, a little behind the Plates of the Trunk, which Hole is ſeen at *a* in *Fig.* 4. where this Hole delivers the Seed down into the Spout A, when it is drawn up into its Place by the String B drawn thro' the Hole at *b* in the End of the Beam, and there tied until it ſtand in the Poſture in which it is ſeen at *f* in *Fig.* 1.

The Shape of this Spout is better ſeen in *Fig.* 5. where A is the Spout, Four Inches long, a full Inch Diameter in the Inſide: Its lowerEnd is circular; but its upper End B is cut at obliqueAngles, ſo that when it is drawn up to its Place, its Edges will touch the lower Surface of the Beam, and incloſe the lower End of the other Spout within it: It is made of thin hammer'd Braſs (as is the other). The Edges of the Piece of Braſs, which make this Spout, are join'd on its hinder Part, for the ſame Reaſon that they are ſo in the other Spout. At *b* there is a Jag cut in one of theſe Edges, and rais'd upwards, by which Jag the String being tied on the Spout juſt below, is hindred from ſlipping upwards.

Joining to the higheſt Part, and made with Part of the ſame Piece of Braſs, turn'd back from the End of the Spout, is its Hinge C, near Three quarters of an Inch long in its Hollow.

D is a thin Piece of Iron, half an Inch broad, and a little longer than the Top of the Sheat, by which the Spout is held up: This Piece of Iron is riveted by a Rivet paſſing thro' an Hole at *c*, and thro' the Sheat, juſt before the Trunk, and thro' another Piece of Iron on the oppoſite Side; both the Pieces of Iron, with their upper Edges touching the Beam, being thus riveted to the Sheat.

The Spout is pinned in by the Screw E, paſſing as by the prick'd Line F thro' the Hole G, and alſo thro' the Hinge C, and ſcrew'd into the Hole of the oppoſite Piece of Iron, correſponding with the Hole G; and then it will appear as in *Fig.* 4.

Inſtead of theſe Pieces of Iron, we ſometimes uſe Pieces of Wood, a little broader and thicker, nail'd on the Sheat.

The Uſe of this Spout is for carrying half of the Seed backwards, ſo that it may drop upon the Chanel, after the Earth is fallen into it: By this means the Seed lying very ſhallow, being only cover'd by a little Earth rais'd by the Harrow, by its Shallowneſs comes up in moiſt Weather, ſooner than the other half, which lies deeper in the Ground; but if the Weather be dry when planted, the deeper half, by the Moiſture of the Earth from the Dews, will come up firſt, and the ſhallow half will not come up till Rain come to moiſten it; ſo that by the ſhallow or deep, the Turnep-fly is generally diſappointed.

Fig. 6. ſhews one of the Tines of a Drill-harrow made of Wood: Its Edge *a b* is made roundiſh at *b*, by which means it raiſes the Earth on its Sides; but does not drive it before: This Edge from *a* to *b* is Six Inches long; from *b* to *c*, being its Bottom, is One Inch and a quarter; from *c* to *d* is the Back, an Inch and an half thick at Top, gradually tapering downwards to *c*, where it is half an Inch thick, being ſhoulder'd all round: It has a flat Tenon A, which paſſes thro' a Mortiſe in the Harrow-head; the Length of which Mortiſe is parallel with the Length of the Harrow-head, into which it is held by a Pin, paſſing thro' the Hole of the Tenon, above the Harrow; as may be ſeen in *Fig.* 7. at *a*; and its Fellow at *b*.

Theſe Two Tines are Eight Inches aſunder at their Points, and Six Inches and a quarter aſunder at their upper Parts, juſt under the Harrow-head. The fore Edge of the Tine A inclines a little to the Left, as the Edge of the Tine B doth to the Right.

Fig. 8. ſhews one of the Legs of the Harrow. At *a* is ſeen the round Tenon, which paſſes thro' the Harrow-head up to its Shoulder, and is pinned in thro' an Hole of the Tenon juſt behind the Harrow-head; upon this Tenon the Harrow-head may turn: The other End has an Hole at *b*, thro' which it is pinned on to the Beam. The Length of the Leg from the Shoulder at *a*, to the Hole at *b*, is Twenty Inches: Its Thickneſs is an Inch and a quarter, and its Breadth an Inch. The Two Legs are ſeen mark'd C, D, in *Fig.* 7. They bend down in the Middle, to give the Harrow the more room for riſing and ſinking; they are parallel to each other, and diſtant a little more than the Breadth of the Beam, that they may have Liberty to move thereon, when one End of the Harrow-head ſinks lower than the other, by the Unevenneſs of the Ground.

The Harrow is pinned on to the Beam by the Iron Pin, *Fig.* 9. paſſing thro' the Hole of the Leg at *g*, and thro' the Beam, and alſo thro' the other Leg on the other Side of the Beam, where the Screw at the End of the Pin has a Nut ſcrew'd on it. This Pin is round from its Head all the Way thro' the firſt Harrow-leg, and thro' the Beam; but all that Part of the Pin, which is in that Leg againſt which the Nut is ſcrew'd, muſt be ſquare; whereby that Part being bigger than the round Part of the Pin, and than the Hole in the laſt-mention'd Leg, cannot turn in the Hole of that Leg; for if it did, the Nut would be ſoon unſcrew'd by the Motion of the Harrow; but the Pin muſt have room to turn in the other Leg, and in the Beam. This ſquare Part of the Pin is ſeen at *a*, *Fig.* 9. The whole Length of the Pin, from its Head to the End of the ſquare Part at *a*, where the Screw begins, is of the Thickneſs of the Two Legs, and of the Breadth of the Beam.

We ſometimes ſet the Legs of the Harrow Two Inches wider aſunder, by making them each an Inch thicker at their fore Ends in their Inſide, and reaching Five or Six Inches behind their Iron Pin: Theſe thicker Parts, bearing againſt the Beam, keep the hinder Part of each Harrow-leg an Inch diſtant from the Sides of the Beam, whereby the Harrow-legs are Six Inches aſunder, inſtead of Four, by means of theſe added Thickneſſes.

When a Drill is taken up to be turn'd, the Perſon that does it, takes hold of the Harrow-head, and lifts it up: The Legs of the Harrow, bearing againſt the croſs Piece, ſupport the whole Weight of the Drill.

When the Harrow does not go deep enough, we tie a Stone upon the Middle of the Harrow-head, by a String that paſſes thro' the Holes at *b*. All the Wood of this Plough and Harrow is Aſh, except the Limbers.

The Hopper of the Turnep-drill is very different from thoſe already deſcribed: It conſiſts of a Box placed into the Middle of a Carriage; which Box is deſcribed in all its Parts, lying open with their Inſides upwards in *Fig.* 10. A is the fore Side of the Box, Five Inches and an half deep, and Six Inches and an half long. B, the hinder Side of the Box, oppoſite to the former, and of equal Dimenſions.

Each End of the Box is made with Three Pieces of Board, of which C the uppermoſt is Three Inches and a quarter deep, and Five Inches long, which Length is the Breadth of the Inſide of the Box. The End of the Piece C, when in its Place, ſtands againſt the prick'd Line *a b* in the fore Side A; the other End ſtanding againſt the prick'd Lines in B, which is oppoſite to, and correſponds with, the prick'd Line *a b*; the fore Side, and hinder Side, being ſcrew'd to the Ends of this Piece by Four Screws.

The Piece D is Two Inches and a quarter broad, and of the ſame Length with the Piece C, and ſcrew'd up to the Bottom of it with Two Screws; and then its End will bear againſt the prick'd Line *b c*, and that which is oppoſite to it in the Side B.

E is the lower Piece of this End, and an Inch and a quarter broad: Its End is to ſtand againſt the prick'd Line *c d*, and its other End at the oppoſite prick'd Line in B. The Piece D muſt be ſcrew'd upon the upper Edge of the Piece E, as the Bottom F muſt be ſcrew'd up to its under Edge, which will ſtand upon the prick'd Line *e f*. The Three Pieces G, H, I, being oppoſite to C, D, E, and of the ſame Dimenſions with them, placed in the ſame manner, make the other End of this Box. At *g* in the Bottom F, appears the Hole which is over the Mortiſe of the Braſs Seed-box, the Shape and Size of which Hole may be ſeen by the prick'd Lines upon the Flanches B, C, of *Fig.* 9. in *Plate* 2. The foremoſt End of which Hole reaches almoſt as far forwards as the

End of the Axis of the Tongue of the Braſs Seed-box, and its hinder End almoſt as far as the hinder End of its Cover *(a)*. The Bottom F, being of the ſame Length with C, D, E, and their Oppoſites, bears againſt the prick'd Line *d h* of the fore Side A, and againſt the oppoſite prick'd Line of B. The Length of this Bottom F is the Breadth of the Inſide of the Box, and its Breadth reaches to the outer Edges of the Pieces E and I, being Three Inches and an half.

All the Jointings of theſe Pieces muſt be at right Angles, and ſo cloſe, that no Seed may run out at them. All the Pieces are of Board, full half-inch thick, except the Bottom, which is thinner.

Fig. 11. ſhews the Bottom of the Box with its under Side uppermoſt, where the light Part A is the Bottom-board, covering the Two End-boards, E and I, in *Fig.* 10. The dark Parts B and C are the under Sides of D and H, in *Fig.* 10. At *a* is the fore End of the Braſs Seed-box ſcrew'd up to this Bottom-board. At *b* is the hinder End of the Braſs Seed-box ſcrew'd up in like manner, the outer Edge of the Flanch of the Seed-box being even with the Edge of the Bottom-board. The End of the Braſs Spindle, with its Fork, appears at C.

Fig. 12. ſhews this Box ſtanding upon its Bottom, with its hinder Side laid open. At *a* is the Hole in the Bottom, under which the Braſs Seed-box is faſten'd, with ſmall Iron Screws, ſquare near the Heads, paſſing thro' the Bottom, and thro' the Holes at each End of the Braſs Box, with their Nuts underneath.

(*a*) Commonly it reaches within half a quarter of an Inch; but if it ſhould only reach within a quarter of an Inch of them, it would not have that ill Conſequence of that Diſtance, as the ſame Poſition would have in the large Seed-boxes; for, in them, the Seed would, in ſuch Caſe, be apt to bear againſt the Bottom of the Hopper, and obſtruct the Motion of the Braſs Tongue, which ſmall Seeds cannot do in the Turnep-ſeed Box.

The Pins muſt touch all the Sides of the Holes in the Braſs, to prevent the Seed-box from moving any Way.

A is the fore Side of the Box. B the hinder Side lying down. C is the Piece H of *Fig.* 10. which makes a ſort of Shelf in the Box at its left End. D at the right End makes another like Shelf, underneath which, the Fork of the Braſs Spindle is turn'd by the Crank in the End of the wooden (falſe) Spindle. By means of theſe Shelves, there is room for the Two wooden falſe Spindles to come the further into the Carriage, without leſſening the upper Part of the Box. E and F are the Two Ends of the upper Part of the Box, made by the Two Pieces G and C of *Fig.* 10. When the hinder Side B is rais'd up, and ſcrew'd to theſe Ends, the Box is complete.

We put a Lid upon this Box, which is hing'd on to its right or left End. This Box (having the Braſs Seed-box at its Bottom) is to be placed into the Middle of a Frame or Carriage.

Fig. 13. ſhews the Inſide of the Carriage lying down. A is the hinder Side, Eighteen Inches long, Dove-tails and all, and Six Inches broad. B the fore Side, of the ſame Length with the hinder Side, and Eleven Inches broad. This Five Inches greater Breadth than the hinder Part is, becauſe a greater Height is required on the fore Side, on account of the Hopper's being drawn, and the Plough held up by that and the Pieces that muſt be fix'd to it. C, D, are its Two Ends, Six Inches long, beſides their Dove-tails, and Six Inches broad. E and F are Two Pieces each Six Inches long, whoſe Ends are to ſtand againſt the prick'd Lines *a b* and *c d* of the hinder Side, and their other Ends againſt the prick'd Lines in the fore Side, which are oppoſite to theſe. The Breadth of each of theſe Pieces is Four Inches: When they are in their Places, their lower Edges come even with the Bottom of the Carriage. Their Uſe is to ſupport the Ends of the Spindles which come juſt thro' their Holes, after each of them have paſſed their Hole at its reſpective End of the Carriage.

All this Carriage is made of Board full half-inch thick: The Ends C and D are made of double Thickneſs by another Piece of Board added to each, that covers all their Inſides, except their Dove-tails. Theſe Boards with which they are lin'd, are nail'd to them, with their Grain going a different Way, and croſſing the Grain of the Board of the End, either at right or oblique Angles. This prevents the Holes from ſplitting out, and makes the Holes of a double Thickneſs; whereby the Spindle is the leſs worn by them, in caſe there are no Braſs Wreaths to enter them.

The middle Pieces E and F are lin'd by their whole Surfaces, in the ſame manner as the Inſides of the Ends are lin'd.

When theſe Ends and middle Pieces are in their Places, a wooden Cylinder, of the exact Diameter of the Holes, is thruſt thro' all Four, to hold them exactly true, whilſt the Ends and middle Pieces are all ſcrew'd faſt into their Places.

The prick'd Lines are drawn all round the Carriage, thro' the Centres of the Holes, and at equal Diſtance from the Bottom of the Carriage, which is an Inch and Three quarters, and the One-eighth of an Inch. This prick'd Line is a Direction how high to nail on the Ledgers G and H, whereon the Box is to ſtand; and the Diſtance the upper Surface of the Ledger muſt be above the prick'd Line, is the Semidiameter of the Braſs Spindle; and the Thickneſs of the Braſs Box above the Spindle, or, which is the ſame thing, the Diſtance between the Centre of the great Hole of the Braſs Seed-box, and the Plane of the Top of its Mortiſe, being half an Inch and half a quarter, ſtrike a Line above the prick'd Line parallel to it, at this Diſtance above, and then nail on the Ledger, with its upper Edge at this Line. This, with its oppoſite Ledger plac'd in the ſame manner, will ſupport the Box with the Axis of the Spindle of the Seed-box, at equal Height with the Centres of the Holes of the Carriage; ſo that if thoſe Holes are parallel to, and equidiſtant from the fore Side and hinder Side of the Carriage, and the Axis of the Braſs Spindle be placed in the like manner parallel to, and equidiſtant from the fore Side and hinder Side of the Box; then when the Box is thruſt down in its Place, upon theſe Ledgers, and the wooden (falſe) Spindles are placed into their Holes, their Axis will fall into a ſtrait Line with the Axis of the Braſs Spindle, as they ought.

Fig. 14. ſhews the Carriage laid open. A is its back Side lying down. B is its fore Side ſtanding up. C is the ſquare End of the left (falſe) Spindle, whereon a Wheel is to be put up to the Shoulders of the Spindle, quite cloſe to the Ends of the Carriage. This Spindle, being an Inch and an half Diameter, is held in its Place, and kept from moving end-ways, by Two Wreaths; the one at *a*, bearing againſt the Inſide of the End of the Carriage, the other Wreath at *b*, bearing againſt the left Side of the middle Piece; which Wreath keeps the Spindle from moving towards the right Hand, as the other does from moving towards the left. D is the ſquare End of the other wooden Spindle, whereon a Wheel muſt be placed in the ſame manner as the other Wheel. This Spindle is kept from moving end-ways by Two Wreaths, in the ſame manner as the other Spindle is; but this right-hand Spindle, being that which turns the Braſs Spindle by its Crank, which enters the Fork, ſhould have its Wreaths of Braſs, like thoſe deſcrib'd in *Fig.* 17. *Plate* 4. Part of which Wreaths entering about Three quarters of an Inch into the Hole of the End and middle Part of the Carriage, being firmly ſcrew'd on to the Spindle, prevent the Friction that would otherwiſe be betwixt the Wood of the Spindle and the

Wood

Wood of the Holes; which Friction wearing the Wood of both, would in time cauſe the Spindle to be looſe in its Holes, whereby its Axis would deviate from the ſtrait Line it ſhould make with the Axis of the Braſs Spindle, and make an Angle with it; and then the Crank would change its Place in the Fork at every Revolution of the Wheels; and if the Hole ſhould be worn very wide, and the Spindle worn much leſs, the Crank might let go the Fork; but when the Wood is of this Thickneſs, and each Hole has Wood in it, with its Grains pointing different ways, it would be many Years before the Holes would become large enough for this to happen, tho' only wooden Wreaths were uſed; and as to the Two Wreaths of the left Spindle, they may be of Wood, becauſe tho' that Spindle ſhould grow looſe, it is no Damage; for it only ſerves to bear up that End of the Carriage; but he that has this Sort of Braſs Wreaths for the hinder Hopper of a Wheat-drill, may take them thence, and place them upon theſe Spindles, and remove them again to the Wheat-drill when that is uſed; for that and the Turnep-drill are very rarely, or never, uſed at the ſame time.

E is the Iron Crank, plac'd into the falſe Spindle, in the manner ſhewn at H in *Fig.* 5. of *Plate* 2. for turning the Braſs Spindle by its Fork; but take care that the End of this wooden Spindle do not approach nearer to the End of the Braſs Spindle than the Diſtance of half an Inch, leſt, if the inner Wreath ſhould grow looſe, the wooden Spindle might bear ſo hard againſt the Braſs one, as to wrench the Seed-box down from the Wood, and then the Seed might run out betwixt the Seed-box and the Bottom to which it is ſcrew'd.

When the hinder Side A is ſcrew'd up againſt the Ends and middle Pieces, then the Box deſcrib'd, being thruſt down into the Carriage, and ſtanding upon the deſcrib'd Ledgers, and at that Diſtance from each

End of the Carriage, that the Seed may drop on the Side of the Funnel, as is before deſcrib'd; the Box is kept in its Place by one Screw paſſing thro' its Back, and the back Side of the Carriage.

The Notch F is cut in the Bottom of the hinder Side of the Carriage, up to the Bottom of the Ledger, for the Convenience of ſeeing the Seed drop into the Funnel.

The round Notch G is made in the Bottom of the fore Side of the Carriage, to make room for one's Hand to go in there, and turn the Setting-ſcrew without taking off the Hopper from the Standards.

This Box and Carriage, ſo fix'd together, compoſe the Turnep-hopper, which is drawn and guided, and alſo holds up the Plough, by Two hollow Pieces of Wood ſcrew'd on to the Outſide of the fore Part of the Carriage; their Ends H and I appearing a little above the Carriage.

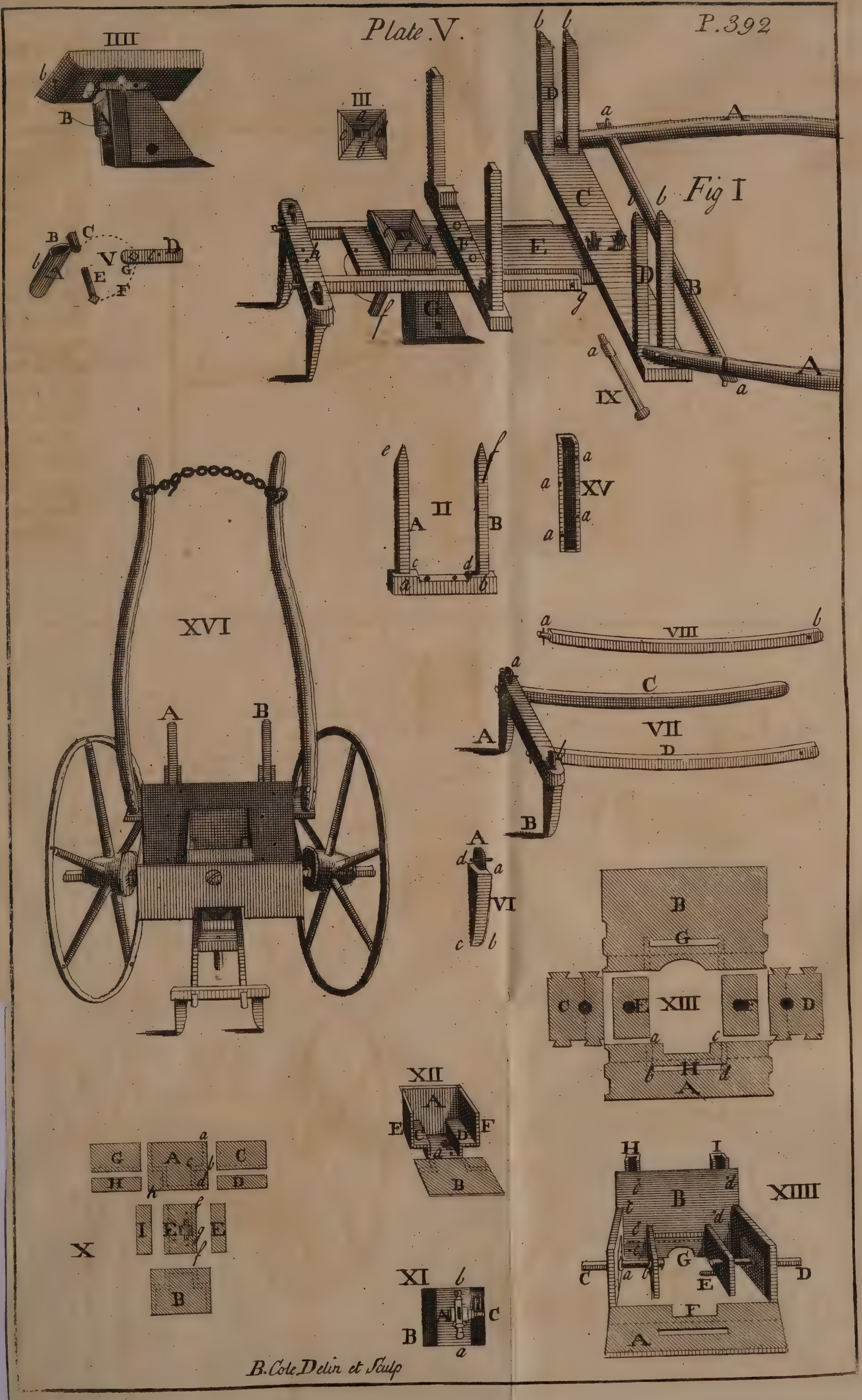
One of theſe hollow Pieces of Wood is ſhewn in *Fig.* 15. The Breadth of its Hollow muſt conform to the Breadth of the Standards, which are One Inch and a quarter broad; but we muſt allow about a quarter of an Inch more in the Hollow for the Swelling of the Wood. The Depth of the Hollow muſt be the Thickneſs of the Standard that is to go in it, allowing about the Eighth of an Inch for the Swelling of the Wood. The Hollow ſhould be a little deeper in the Middle than at each End; becauſe the Standard ought not to bear againſt any thing, except at or near the upper and lower Part of the Carriage. Altho' the End of theſe Pieces come a little higher than the Carriage in this Hopper, yet I think it is better that theſe hollow Pieces come no higher than even with the Top, nor deſcend any lower than even with the Bottom of the Carriage; and then the Length of each of theſe Pieces need be no more than Eleven Inches, which is the whole Depth of the Carriage.

The Wood on each Side of the Hollow, ſufficient for the Holes *a*, *a*, *a*, *a*, muſt be about half an Inch broad. The beſt way for fixing them on, is whilſt the Standards are in them, placing a ſmall Piece of Wood at each Corner of the Hollow, betwixt the Standard and the Wood, to the end that there may be no more room on one Side of a Standard than on the other Side; then ſcrew them on (parallel to and equidiſtant from their reſpective Ends of the Carriage) by Four ſmall Screws each, the one at *c*, *c*, *c*, *c*, and the other at *d*, *d*, with Two below; the Heads of theſe Screws being on the Inſide of the Carriage, and their Nuts on the Outſides of the hollow Pieces; then pull out thoſe little Pieces of Wood, that were to keep the Standards in the Middle of the Hollows, whilſt the Holes for the Screws were bored, and then the Turnep-Hopper is finiſhed, and being put on upon the Standards A, B, in *Fig.* 16. is ready to go to Work; and in this Figure the whole Turnep-drill may be ſeen as in the Proſpect of a Perſon following it at Work, except that this Figure has not the double Standard, nor Marking-wheels; becauſe we never uſe them for drilling Turneps, except it be on the Level, which we very rarely do.

The Circles of the Wheels of this Hopper go Twenty five Inches aſunder; were they farther aſunder, they would not go ſo well upon the Ridges; or were they nearer together, they might not hold up the Plough ſo ſteadily, but that one Wheel might happen to be rais'd from the Ground, by the deſcending of the oppoſite Limber; and if it ſhould happen to be the Wheel that turns the Crank, no Seed would be deliver'd out whilſt the Wheel was rais'd above the Ground; ſometimes we uſe Wheels of Twenty-ſix Inches Diameter, ſometimes Thirty, and at intermediate Diameters, with this Hopper.

The beſt Wood for making all Sorts of Hoppers is Walnut-tree or Elm; our Beams and Standards we make of Aſh.

Plate V.



B. Cole Delin et Sculp

What is meant by Wood-ſcrews, are taper Screws made with Iron, having very deep Threads, whereby they hold faſt when ſcrew'd into Wood, and their Points will enter into ſoft Wood without boring any Hole for them into the Wood they are to take hold of; but near their Heads they are round, and have no Thread, and that Part of them muſt always be in a bor'd Hole thro' that Part of a Board that is to be drawn cloſe.

If the Standards ſhould be much ſwollen by being wet, it may be proper to anoint them with Soap.

In drilling, when the Wind is very ſtrong, and the Hopper goes high above the Funnel, the Seed might be blown over it, if we did not take care to guard it from the Force of the Wind; and for doing this there are many Ways: Sometimes we nail a Piece of Linen Cloth round the Ends, and the fore Side of the Hopper; or elſe we nail on a Piece of old Hat, or Shoe-leather, round the Edges of the Funnel, to raiſe it higher; or if the Hopper go a great deal above the Trunk, we nail up a Pipe of Leather to the wooden Bottom of the Box, which Pipe, being about an Inch wide at Bottom, protects the Seed from the Wind, till it arrives ſo near the Funnel, that the Wind cannot blow it over.

If we would have a long Hopper, to plant many Rows at once, of Clover or other fine Seeds, it is eaſy to make each of theſe wooden (falſe) Spindles turn Two or Three Braſs or Iron Spindles; but then, as in all other Caſes, where the ſame Hopper is to ſupply more than one Chanel with Seed, each of its Wheels muſt have Liberty to riſe without the other, as thoſe of the hinder Hopper of the Wheat-drill do.

CHAP. XXIII.

Of the HOE-PLOUGH, *&c.*

PLATE 6. *Fig.* 1. is the Hoe-Plough in a ſide View. A is the Beam and Plough-tail, being much the ſame with that of the common Plough deſcrib'd in *Fig.* 1. of *Plate* 1. The Beam of ſuch a common Plough, being cut off, and ſcrew'd up to this Plank, and its Limbers, might make a Hoe-Plough. The Share of this, from its Tail to the fore Part of its Socket, is Two Feet One Inch long, and from thence to the End of the Point, Ten Inches and an half: This is the Meaſure of the under Side of the Share. B is the Plank, Two Feet Seven Inches and an half long, Two Inches and an half thick, and Nine Inches broad. C, D, are the Nuts of the Two Screw-pins, which hold up the Beam to the Plank. E is the Nut of the Draw-pin, which Pin has a Crook underneath, whereto one of the Links of the ſhort Chain of the Whipper is faſten'd for drawing the Plough; the only Uſe of this Nut is, to hold the Pin from dropping out by its own Weight, and that of the Chain and Whipper; but often, to avoid the Trouble of ſcrewing and unſcrewing the Nut, we ſupply its Uſe by a ſquare Pin a little bigger than the Hole, which we drive up by an Hammer, ſo tight, that it may not drop out of itſelf; but can eaſily be driven out by a few Blows of the Hammer, as often as it is neceſſary to remove it into another Hole. F, G, are the Two Limbers; they are ſcrew'd on to the Plank by Four Screws and Nuts: The under Surface of the Limbers by their whole Length are parallel to the Plank, and to the upper Surface of the fore

End of the Beam, contrary to the manner of placing the Limbers of the Drill-Ploughs; becauſe their Planks being always parallel to the Bottom of their Shares, if their Limbers were parallel to their Beams, as theſe are, the fore Ends of their Limbers would not be elevated higher than the Plank, but would go within a Foot of the Ground, inſtead of being elevated almoſt as high as the Horſes that draw them; and the upper and under Surfaces of this Plank muſt not be parallel to the Share, but muſt make the ſame Angle with it as its Limbers and Beam do.

Theſe Limbers ought to crook outwards from each other all the Way, till they come within about a Foot of the Chain, much more than the Drill-Limbers need to do; becauſe the Middle of the Plank of the Drill follows directly after the Horſe, but the Middle of the Plank of the Hoe-Plough very ſeldom does; and therefore there muſt be the more room betwixt theſe Limbers. Likewiſe there muſt be the more room betwixt the fore Part of the Limbers, becauſe oftentimes the right Limber muſt be rais'd, and the left depreſs'd, in holding the Plough towards the left Side (for if it ſhould be held towards the right Side, the Share would go upon the Fin, and its Point be raiſed out of the Ground, unleſs it were on a Surface that had a Declivity towards the Right). The Diſtance between the fore Ends of theſe Limbers is Two Feet Eight Inches.

The Strength and Stiffneſs of theſe Limbers muſt be ſuch, that there may be no Bending betwixt their fore Ends and the Tail of the Beam; for if they be too weak, ſo as to yield to the Weight of the Furrow, the Point of the Share will deſcend into the Ground, and its Tail will riſe up, and then the Plough cannot go well. The ſhorter they are, the ſtronger and ſtiffer will they be, of the ſame Thickneſs. We may make them juſt of ſuch a Length, that there may be room for the Horſe before the Bar H (which holds the Limbers at their due Diſtance). Theſe are from their Ends to the Bar, Four Feet Ten Inches long and from thence to the Plank Ten Inches, and Three Inches and an half ſquare at the Bar.

I is the Whipper. K, L, are its Notches, whereunto the Traces both of the Thiller, and of the Horſe next before him, are faſten'd. The Length of the Whipper is uncertain; but when we hoe betwixt Rows, when the Plants are grown high, we make it as ſhort as it can be, without galling the Horſe's Legs by the Traces.

We ſet this Plough to go deeper or ſhallower by the Chain of the Limbers; the changing of whoſe Links to the Crook M has the ſame Effect as changeing the Pins to different Holes of the Crow-ſtaves of a common Plough.

Fig. 2. is the Beam with its Mortiſe and Holes; its Crooking down at the Tail is not very material; but it cauſes the hinder Sheat to be a little the ſhorter below the Beam, whereby it may be ſomething the lighter, and yet of the ſame Strength as if it were longer. Its whole Length is Four Feet Ten Inches: We make its Breadth and Thickneſs ſuch, that it may be as light as it can be without Bending. A is the Mortiſe thro' which the hinder Sheat paſſes. B is the Mortiſe for the fore Sheat, upon which it is pinn'd up. C is a Hole in the Beam, into which the End of the left Handle being driven, holds it from moving, and is the beſt Manner of faſtening this Handle of a Plough. D, E, are the Holes, thro' which the Two Legs of the double Retch paſs, and are there held up by their Nuts. F is the Coulter-hole. G is the hinder Hole, by which the Plough is held up to the Plank. H and I are the Two foremoſt Holes of the Beam, thro' one or the other of which paſſes the Pin which holds the Beam to the fore Part of the Plank. Theſe Holes muſt be made as near together as they can be, without Danger of ſplitting them one into another; to prevent which there are ſeveral Ways: The one is by driving in Two ſquare Pins croſs the Beam, under the prick'd Line *a b*, before the Holes are bored, which will prevent the Grain of the Wood from being forced out of one Hole into the other; or theſe Holes may be plated with Iron above and below, which will have the ſame Effect, and then there need not be more than One Inch between Hole and Hole.

Fig. 3. is the Plank apart, which by its Holes, and prick'd Lines, ſhews the different Manner of placing the Beam. *a*, *a*, *a*, *a*, are the Four Holes for ſcrewing down the Limbers to the Plank.

Suppoſing the Path of the Horſe to be a ſtrait Line, and the prick'd Line *b i* (which is at right Angles with the Plank, and equidiſtant from each Limber) to go exactly over it, without making any Angle on either Side of it; then the Beam muſt be placed at right Angles with the Plank, to the end that the Share may go parallel to the Horſe-path, excepting that very ſmall Inclination that its Point has to the left, ſhewn by the prick'd Lines in *Fig.* 1. of *Plate* 1. But this Plough ſeldom follows the Horſe in that manner. The ſaid prick'd Line *b i* generally makes Angles with the Horſe-path; elſe when the Beam ſtood near the left Limber, and the Draw-pin near the right Limber in the Hole 9. (which it muſt do to keep the Share parallel to the Horſe-path) the Weight of the right End of the Plank and its Limber would be too heavy for the right Hand of the Holder to manage; and if the Draw-pin be removed (ſuppoſe) to Hole 7. the Paralleliſm of the Share with the Horſe-path will be loſt, and the Point of the Share may be inclin'd too much towards the Left; and when a Furrow is to be plowed on the right Side of the Horſe-path, the Beam muſt be removed nearer to the Middle of the Plank, and the Draw-pin muſt be plac'd on the left Side of the Beam, ſuppoſe to the Hole 2. This will bring the greateſt Part of the Plank to the right Side of the Horſe-path; and then the Share, ſtanding at right Angles with the Plank, will make a very large Angle with the Horſe-path, and then the Plough will not perform at all. Therefore it being neceſſary, that the Share always go parallel to the Horſe-path, and often as neceſſary that the Plank go at oblique Angles to the Horſe-path; it follows then that the Beam ſtand at oblique Angles with the Plank, to preſerve the Parallelism to the Horſe-path; and this cannot be done but by the Holes which are ſhewn under the prick'd Lines which croſs the Plank.

The Holes A, B, C, are thoſe to one of which the Beam is ſcrew'd up by its Hole G, in *Fig.* 2. Theſe Holes are made as near to the hinder Edge of the Plank, as they can ſafely be, without Danger of tearing out; which is generally about an Inch diſtant from the ſaid Edge.

Every one of theſe Holes are anſwer'd by Three others, near the fore Edge of the Plank, as the Hole B has, at the fore Edge of the Plank, the Holes D, E, F. D, E belong to the Hole I of the Beam *Fig.* 2. Theſe Two Holes are made as near together as they can be without breaking into one another. F anſwers the Hole H in *Fig.* 2. and is made between D and E, as near them as ſafely it can.

When the Beam is ſcrew'd up at B and F, and makes the ſame Angles with the Plank, as the prick'd Line *b c* doth; then the Draw-pin ſtanding in the Hole 8 or 9. will bring the Plough ſo much to the Left, that the Share will point too much towards the Right; then remove the fore End of the Beam to the Hole D, and then the Beam will make the ſame Angle with the Plank as the prick'd Line *c d*, which may bring the Share to be parallel to the Horſe-path nearly enough: But if the Draw-pin ſhould be plac'd in the Hole 1. then the Plank would go ſo much on the Right of the Horſe-path, that the Share would point vaſtly too much towards the Left, ſtanding in either of theſe Two Poſitions: Therefore the foremoſt Pin muſt be removed to the Hole E, and then the Beam being at the ſame Angles with the Plank as the prick'd Line *f g*, it may be parallel to the Horſe-path, or ſo nearly, that by removing the Draw-pin one Hole, it may be made perfectly ſo.

Note, That tho' here are but Nine Holes for the Draw-pin; yet we uſually make many more in our Planks: And ſometimes by changing the Draw-pin either Way into another Hole, tho' that Hole be but an Inch diſtant from the former, the Share is brought right without any Inconvenience.

The Holes A and C have each of them their oppoſite Holes, which (when the Beam is placed into either of the Two) have the ſame Effect, for keeping the Share parallel to the Horſe-path, as the Hole B and its Three oppoſite Holes have; and if either of the Holes belonging to A, B, or C, ſhould not bring the Beam ſufficiently oblique to the Plank, for the Share to be parallel to the Horſe-path, when the Draw-pin is in ſome one particular Hole, then there may be another Hole bor'd before, on the Right or Left, for the fore Pin to paſs thro' by the Hole H of the Beam *Fig*. 2. which will incline the Beam a little more to the Right or Left, as occaſion requires; and if none of all theſe be ſufficient, the Plank may be turn'd the other Side upwards; and the Beam being faſtened there by the hinder Screw into any one of thoſe Holes, which were next to the fore Edge of the Plank before it was revers'd, there may be a new Set of Holes to anſwer the fore Pin, of which that which was an hinder Hole before the Plank was revers'd, may be one. Theſe may ſet the Beam at different Angles from any of the firſt Holes; ſo that there may be at one End of the Plank Six Syſtems of Holes, Three on the one Side, and Three on the other; and if we have a mind to make yet more various Poſitions of the Plough, we may turn the Plank, End for End, and there make Six different Syſtems of Holes.

But, inſtead of turning the Plank, it would be better to have a Fourth Hole in the Beam, ſtanding as near to the hinder Hole as H doth to the fore Hole; to anſwer which Fourth Hole, there may be Two Holes in the Plank, one at each Side of the hinder Hole of every Syſtem at proper Diſtances, to ſet the Plough ſtill at more different Angles with the Plank; and theſe, I believe, will be more convenient for the Purpoſe than the different Holes in the fore Part of the Plank, it being eaſier to remove the hinder Screw than the fore Screw; becauſe if the Plank and Limbers are not held up by ſomebody, whilſt the fore Pin is out, their Weight will wrench out the hinder Hole of the Plank by that Screw; but whilſt the hinder Screw is out, there is no need of holding up the Plank, becauſe its Weight, bearing upon the Beam, cannot injure the foremoſt Hole, whilſt the Limbers bear upon the Horſe. Upon this account, I wonder we had not made the Holes, for changing the Poſition of the Beam, at the hinder Part of the Plank rather than the fore Part; which convinces me, that new Inſtruments are ſeldom perfect in the Beginning.

We can alſo alter the Standing of the Beam, by cutting away the Wood on one Side of an Hole, and placing a Wedge on the oppoſite Side of the Pin.

The Holder may make ſome Alteration in the Going of the Plough by the Handles.

The Reaſon we never ſet the Beam on the right Half of the Plank is, that the Plough always turns its Furrow towards the Right-hand; and the ſtrait Side of the Share and the Coulter never go ſo near to a Row on the Right-hand, by the Breadth of Two Furrows, as it does to a Row on the Left-hand.

If by the Drawing of the fore Horſe or Horſes, the Plough ſhould bear too hard upon the Thiller, it may be help'd by making a Row of Holes near the hinder Side of the Plank, for the Draw-pin, inſtead of thoſe in the Middle; for the farther backwards the Draw-pin is plac'd, the leſs will the Limbers bear on the Thiller, eſpecially when drawn by more Horſes than one; becauſe the fore Horſes draw the Limbers more downwards than the Thiller doth, as may be ſeen in *Fig.* 4.

Fig. 4. ſhews the manner how the Hoe-Plough is drawn, and how the Traces are fix'd to it. The Traces of both Horſes are faſtened to the Notches of the Ends of the Whipper at *a* and *b*. The Traces of the Thiller by their fore Part are faſtened to an Hook, or Ring, on the Wood of the Collar, as is uſual for other Thillers; and the fore Part of the next Horſe's Traces is faſtened to his Collar in like manner; but theſe Traces, being twice as long as thoſe of the Thiller, muſt be held up in the Middle by a Piece of Cord or Chain, as at *c*, where one End of it is faſtened to the Trace, and paſſes over the Top of the Collar, behind one of the Hames, and before the other to keep it from ſlipping backwards or forwards; its other End is faſtened to the oppoſite Trace on the other Side, as this End is at *c*. This prevents the Chain from falling down, and getting under the Horſe's Legs in turning; but beware that this String or Chain be not ſo ſhort as to hold up the Traces higher than their ſtrait Line; for that would preſs upon the Collar, and gall the Thiller, beſides occaſioning the Plough to be drawn too much upwards; for this drawing of the fore Horſe by a different Line from that of the Thiller, is a great Advantage for keeping the Plough the firmer into the Ground.

If there is another Horſe, his Traces are faſtened at the Collar of the Second, in the ſame manner as in drawing of a Waggon.

When we hoe betwixt Rows, where the Plants are very high, as thoſe of Turnep-ſeed, which are much higher than the Horſes, to turn a new Furrow up to the Row, when there is a Trench in the Middle of the Interval, where the Horſes muſt go, we find it beſt to place the Beam by the Holes B and E, in *Fig.* 3. and the Draw-pin near the left Limber, which brings the Tail of the Plough to the Right-hand, and the fore Ends of the Limbers being towards the Left, the End of the right Limber (by turning the Handles a little to the Left) bears againſt the wooden Saddle at *d*, and cannot hitch into or take hold of any of the Plants to tear them. And that no Part of the Limber may take hold of any Plant, we make it very ſmooth from one End to the other, and cut off the Corner of the Plank equal with the Limber, that the Plants may ſlip by it without hanging in it, or being broken by it. The Whipper ſtanding towards the left End of the Plank, its End *b* does not reach ſo far towards the right as to take hold of the Plants, its End *a* being over the Interval, where no Plants are; and to keep its right End the more out of Danger of hurting the Plants, we place the Hook of its Chain nearer towards this End, by which means the left End, becoming heavier, ſinks lower, and raiſes the right End higher; and the higher it is, the more ſecure the Plants will be from it; becauſe they are held off by the Limber above.

This way my Turnep-ſeed has been ho'd, when one would have thought it impoſſible for a Plough and Horſes to go betwixt the Rows without deſtroying the Crop. Almoſt in this manner we give our Wheat the laſt Hoeing, to turn the Furrow a Second time towards the Row. When the Plants of the Rows are very high, the Driver muſt go in the next Interval, on the Left of the Plough; and the Holder has a Cord, like the Reins of a Bridle, which he lays over the End of the Draw-pin, which keeps it from falling down, until he has occaſion to uſe it for guiding or turning the Thiller.

When we turn the Furrow from the Row (which will then be ever on the left Side of the Plough), the Plough muſt be ſet in a very different and contrary

Poſture; but then the Plants commonly being low, there is no Danger of the Whipper's or Limber's hitching or taking hold of them; but the Driver muſt take care, that he does not tread on them, nor ſuffer any of the Horſes to do ſo; and they of themſelves, when they are not blind, take all the Care they can to avoid it; and I obſerve, that the Plants are oftener injured by the Driver, than by the Horſes.

'Tis in this laſt-mentioned manner of Hoeing, when we go very near to the young Plants, the Firſt or Second time, that we muſt take care of burying them with the Earth, which (eſpecially when dry and fine) is apt to run over to the left Side of the Plough; this we can in great meaſure prevent, when the Ground is clean, by nailing with Three or Four Nails a very thin ſquare Piece of Board to the Sheat, with one Corner bearing at, or below, *a*, in *Fig.* 1. and its other lower Corner bearing on the Back of the Coulter on its left Side at *b*, its upper Corner reaching to *c*, or higher; its fore End is ty'd on to the Coulter by a leathern Thong paſſing thro' an Hole very near the End of the Board. The lower Edge of the Board muſt come no lower than the prick'd Line *a*, *b*, which, at *b*, is juſt even with the Surface of the Ground, before it is rais'd by the Share; for if this Board ſhould be ſet down too near the Share, the Plough would not go; but, being ſet in this manner, it prevents the Earth (when never ſo much pulveriz'd in the drieſt Weather) from running over upon the Plants to bury them, tho' the Plough go very near them; except in this caſe, we never uſe a Board, the Earth running over to the left Side, being often advantageous in Hoeing; for it changes more Surface of the Ground, than if it went all to the right; and when in Summer we hoe from the Wheat-rows, not going very near to the grown Plants, this Earth that runs over the Share to the Left, helps to mend ſuch Places where the Furrow was not thrown up cloſe enough to the Row by the precedent Hoeing.

The firſt time we turn a Furrow towards the Row, the Horſes go in the Trench near to it, and the Plough ſtands on the left Side of the Horſe-path, almoſt in the ſame manner as when the Furrow is turn'd from the Row; but we very often make uſe of a common Plough, for throwing down the Ridge, which has lain all the Winter in the Middle of the Interval. One Wheel, going on each Side of that Ridge, holds that Plough to a great Exactneſs for ſplitting this Ridge into Halves, which the Earth-board, being ſet out for that Purpoſe, throws up to the Row on each Side of the Interval.

We alſo very often make uſe of the Two-wheel'd Plough, for raiſing up the Ridges, whereon we drill the Rows; not but that the Hoe-Plough will do every thing that is neceſſary to our Huſbandry: Yet the common Ploughs being heavier than we uſually make our Hoe-Ploughs, they by their Weight, and Help of their Wheels, go a little ſteadier; and beſides the Ploughmen, being more accuſtom'd to them, prefer them before all other, where their Wheels are of no Prejudice.

I never ſaw neater Ridges rais'd by any Plough, than by the Hoe-Plough, nor finer Plowing; and I believe that were it made as heavy, and as ſtrong, it would outdo the Swing-Plough, in plowing miry Clays, where Plough-wheels cannot go; but I, haveing no ſuch Land, have never made any Hoe-Plough heavy enough for it. However, I am convinc'd, by the many Trials which I have ſeen, that no other Plough can be uſed for every Horſe-hoeing Operation, ſo effectually as this I have now deſcrib'd.

The making the Hoe-Plough is not difficult for a good Workman; and a few of the Holes for ſetting the Beam are ſufficient, provided they are made in their proper Places, which is impoſſible for me to deſcribe exactly in a Number that is no more than neceſſary; becauſe the Diſtance the Plough muſt go from the Horſe-path on either Side, is uncertain, as the Largeneſs or the Depth of the Furrow is; and for that Reaſon, it is as impoſſible for me to direct the Ploughman to the particular Angles, at which his Beam muſt be ſet with the Plank, to keep the Share parallel to the Horſe-path, as it is to direct a Fiddler, how far he muſt turn his Pegs to give his Strings their due Tenſion for bringing them all in Tune, which without a Peg to each String could never be done; but when he has his juſt Number of Pegs, his Ear will direct him in turning them, till his Fiddle is in Tune; ſo the Ploughman by his Eyes, his Feeling, and his Reaſon, muſt be directed in the ſetting his Plough; but without a competent Number of Holes, he can no more do it than a Muſician can tune Four Strings upon one Peg. And I am told, that ſome Pretenders to making the Hoe-Plough have fix'd its Beam to the Plank immoveable, which makes it as uſeleſs for hoeing betwixt Rows, as a Violin with but one Peg to its Four Strings would be for playing a *Sonata*.

Fig. 5. ſhews the Sort of Yoke, that is us'd on every Ox that draws in a ſingle File, as they always muſt when they work with the Hoe-Plough; but after they have been accuſtom'd to draw double *(i. e.* Two abreaſt) they muſt be practis'd for about a Week to draw ſingle, before they are ſet to Hoeing; for otherwiſe they will be apt to demoliſh the Rows, one running off to the Right-hand, expecting his Fellow to come up with him on the Left, and another will run off on the Left to make room for his Companion to go abreaſt with him on the Right, endeavouring to go in the manner in which they us'd to be placed for drawing in Pairs.

I ſuppoſe I need not give any Caution about muzling the Oxen when they hoe; becauſe they will eat the Plants as ſoon as they come an Inch above the

Ground, and that will ſhew the Neceſſity of it; but there is no Occaſion to muzzle the Horſes until the Plants are grown as high as their Noſes, when rein'd up, as in *Fig.* 4.

Fig. 6. is an Inſtrument of Pulveration, which might have been ſufficiently deſcrib'd by its Matter, Weight, and Dimenſions, without any Portrait, were it not to ſhew the particular Manner of drawing it, being very different from that of a common Roller, whoſe Frame is difficult to make, and coſtly; but this, being only Three Feet long, is drawn by a ſimple Pair of Limbers, held together by the Two Bars A and B, firmly pinn'd in at their Ends.

Its Gudgeons muſt not come out beyond the outer Surface of the Limbers, leſt they ſhould take hold of the Plants, when drawn in the Intervals; alſo the hinder Ends of the Limbers, behind the Gudgeon, ſhould crook a little upwards, for the ſame Reaſon.

This Stone Cylinder is Two Feet and an half Diameter, and weighs Eleven hundred Weight beſides the Limbers. It muſt never be us'd but in the drieſt Weather, when neither the Plough nor Harrow can break the Clods; and then being ſo very ponderous and ſhort, it cruſhes them to Powder, or into ſuch very ſmall Pieces, that a very little Rain, or even the Dews (if plentiful), will diſſolve them.

I have had great Benefit by this Roller in preparing my Ridges for Turneps. The Weather proving dry at *Midſummer* (which is the beſt Seaſon for planting them), the Land was in Pieces like Horſe-heads, ſo that there was no Hope of reducing them fit for planting with Turneps that Year; the Clods being ſo very large, that they would require ſo many Viciſſitudes of wet and dry Weather to ſlack them; but this Inſtrument cruſh'd them ſmall, and the Plough following it immediately, the Ridges were harrow'd and drill'd with very good Succeſs.

I have alſo made uſe of it for the ſame Purpoſe in the Middle of a cloddy Field, where it pulveriz'd the Clods ſo effectually, that the Benefit of it might be plainly diſtinguiſh'd by the Colour and Strength of the Two following Crops, different from the other Parts of the Field adjoining on both Sides, whereon the Roller was not drawn.

But cruſhing has ſuch a contrary Effect from ſqueezing, that if this Roller ſhould be us'd when the Land is moiſt, it would be very pernicious, by unpulverizing it; of which I am ſo cautious, that ſometimes I let the Roller lie ſtill for a whole Year together.

There is alſo a long triangular Harrow, which is ſometimes uſeful in the Intervals when the Earth is of a right Temper betwixt wet and dry; but there is no need to deſcribe it, and I ſcarce uſe it once in Two or Three Years.

The Diameters of the wooden and iron Pins and Screws, with their Holes, and the Sizes of the Nails to be made uſe of in all the deſcrib'd Inſtruments, I leave to the Diſcretion of the Workmen, who, if they are Maſters of their ſeveral Trades, cannot be ignorant of ſuch Matters.

Fig. 7. and *Fig.* 8. ſhew the Lands of Turneps mention'd at the Beginning of this Work.

AN APPENDIX CONCERNING

The making of the DRILL, *and the* HOE-PLOUGH, *&c.*

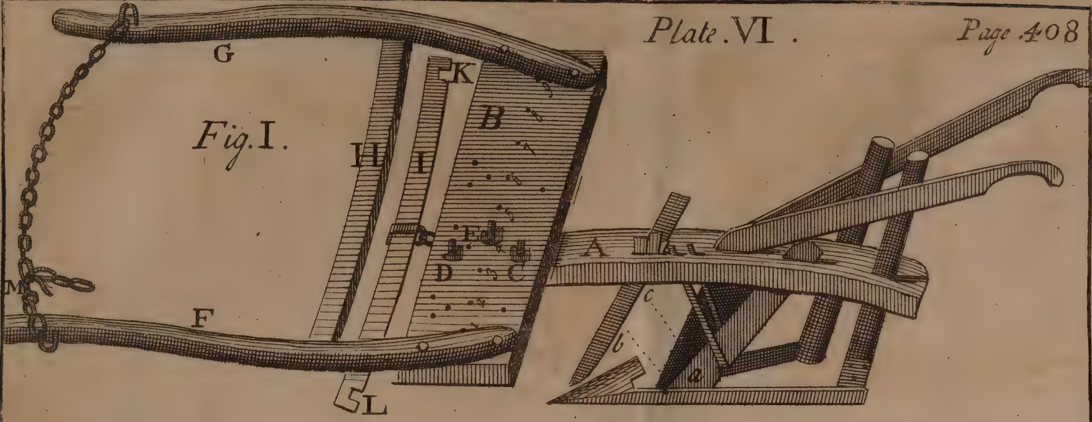
TO a Workman, who would make theſe Inſtruments, I would add the following Directions.

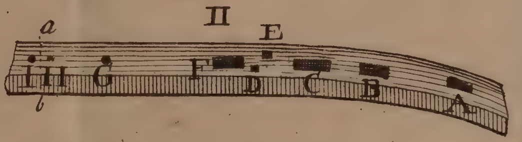
The Firſt thing to be done for making the Drill, is to place half a Sheet of Paper to the Back of Plate 2. by paſting it on to its Margin; and likewiſe another half Sheet to Plate 3. in the ſame manner.

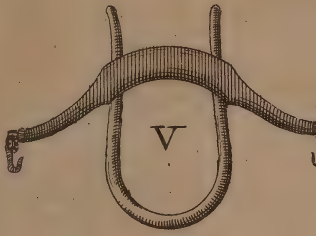
Then with a Needle prick through all the Out-lines of A, B, C, and D, in *Fig.* 2. which will mark out both Sides, and both Ends of the Mortiſe of the Turnep Drill-box. Alſo prick through the Out-lines of the great Hole in the middle of A, and of the elliptical Hole in B. Alſo prick the little Hole at E, in A; and at F, in B. Prick through the prick'd Line *p q*, in B; which is the Line to which the Setting-ſcrew *Fig.* 6. or *Fig.* 12. that is to paſs thorough the Hole in C, muſt be parallel.

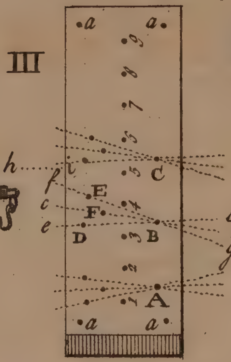
When the Paper is taken off, cut out of it the ſaid A, B, C, and D, by the Pricks made by the Needle.

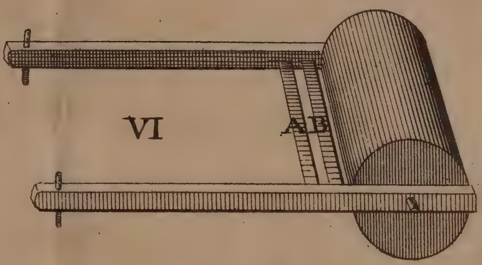
Then cut the ſame in Paſtboard, by laying theſe Pieces of Paper thereon (becauſe Paſtboard, being ſtiffer than

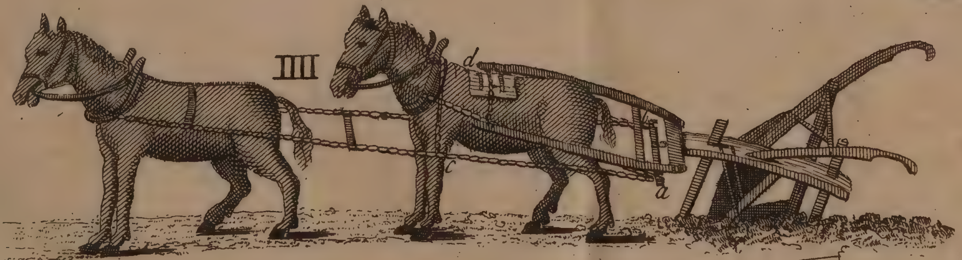


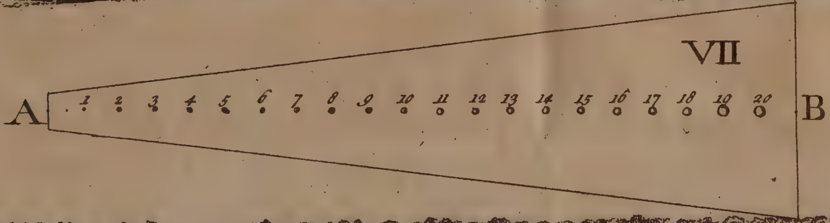


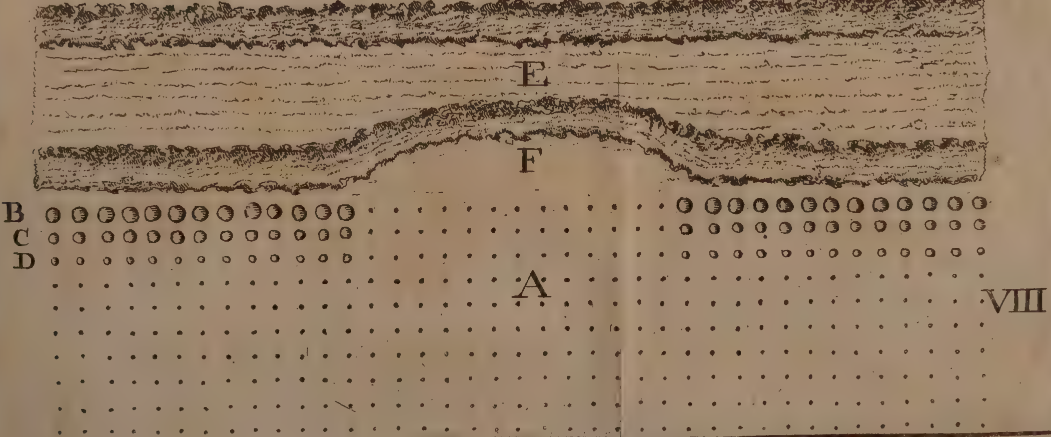












B. Cole Delin. et Sculp.

than Paper, will be more fit for the Uſe). Draw a Line with Ink on the prick'd Line, *p q*.

The Hole in C muſt be ſomething larger than in the Cut, becauſe the Setting-ſcrew muſt be ſo, being beſt to be of Braſs, which is leſs apt to ruſt than Iron, of which Metal it was formerly made; but Braſs, being weaker, requires the more of it to equal the Strength of Iron.

The Wreath, *Fig*. 14. is not neceſſary, becauſe the Slider, *Fig*. 15. is ſufficient without it; but then care muſt be taken, that the Edges of its Claws A B, which rub againſt the Cylinder of E, in *Fig*. 9. be taken off, to prevent their cutting it. This Slider is ſometimes made of Braſs, and ſometimes of Iron.

Thus the Workman will have the Sides and Ends of the Turnep-mortiſe, which make the Whole of it, whereby he may make it exactly in ſoft Wood.

Fig. 7. call'd the inner Cylinder, being put into the Cylinder A, of the ſteel Tongue, *Fig*. 4. whereby the Holes for the Axis of the Tongue, being the lower from the Top of the Mortiſe, do not only ſecure the Edges of the Mortiſe from breaking out, but alſo give room for the Flanches B, C, in *Fig*. 9. to be made to reach as far forwards as the Axis of the Tongue, and farther: Hereby the Hole, in the Bottom of the Hopper, may be as wide at the fore End, as at the prick'd Line at the Letter B.

The Notches in the Spindle, *Fig*. 5. ſeem to appear deeper than is uſual for Turnep-ſeed; but I remember I have drill'd Furze-ſeed with a Turnep-drill without altering the Notches. As for the Shape of theſe Notches, they are ſo fully deſcribed in *Fig*. 6. and *Fig*. 8. of *Plate* 3. that I can add nothing to that Deſcription; only that thoſe being for the Wheat-drill, the Size of Notches for the Turnep-drill muſt be leſſer in ſome proportion to the leſſer Size of the Seed.

For making the Wheat-drill do the ſame as for the Turnep-drill. The *Fig*. 3. in *Plate* 2. is one Side of the Mortiſe, by which muſt be made Two in Paſtboard. *Fig.* 10. in *Plate* 2. and *Fig.* 9. in *Plate* 3. are the Two Ends of it.

The Cover that prevents the Wheat from falling down on the hinder Side of the Spindle, is one intire Piece of Braſs, which is mark'd B in *Fig.* 3. of *Plate* 3. but the Shape of it, with its Hole whereby it is held in by a Screw, is only ſeen in the Side, *Fig.* 3. of *Plate* 2. and there deſcribed by prick'd Lines; and by pricking through them, the Shape of the End of the Cover may be taken, which Cover is of the ſame Shape from End to End.

The Joyner who cannot by theſe Additions, and the Explanations of the *Plates*, make theſe Drills in Wood, doth not deſerve the Name of a Workman.

When he has once made them whole, he can eaſily make them in Halves like *Fig.* 8. in *Plate* 2.

By theſe Halves the Founder will make his Moulds proper for caſting them in the beſt Braſs. But in theſe Halves for Caſting, there muſt be no other Holes, but the great Holes, and the Hole for the Setting-ſcrew.

The great Hole in the Mould muſt be largeſt at E, in *Fig.* 9. *Plate* 2. and leſſer in the Inſide in *Fig.* 8. for as it muſt be of a conical Shape for making the Core, if it ſhould be caſt bigger within, when the Whiteſmith bores it (as he muſt) to an exact Cylinder, the End E would be in Danger of burſting by the Force of the Boring, as it is much thinner than in the Mortiſe. And beſides this, if there ſhould be any little Flaw in the Edges of the Hole within the Mortiſe (which the Founder muſt avoid as much as poſſible), it may perhaps be bored out by means of the Hole's being leſs there. The Hole muſt be ſomething leſs in the Mould than its proper Size, even where it is largeſt; elſe it may happen, that in boring it to a true Cylinder it may become too big. And I believe, in the Cooling of the Braſs, the Hole grows bigger as the Spindle grows leſs.

For the Hole of the Setting-ſcrew, lay on upon the dark Part of *Fig*. 8. one of the Paſtboard-ſides; and from the black Line *p*, *q*, draw a Line coincident to it as on the Braſs, for making the half Hole A by; and the other Half of it on the oppoſite Half-ſide.

Theſe Paſtboards will be very uſeful to the White-ſmith, for directing him to find the Places where the Holes for the Axis of the Tongue, and thoſe for ſcrewing the Two Halves of the Mortiſe together, are to be made. I adviſe againſt boring the great Hole with a Tool (a Bit) with more than Four Edges; for it would be apt to tear the Braſs.

The great Hole of the Turnep-drill is bored with Tools like thoſe wherewith a Gun is bored. But the Wheat-drill is bored with a Screw-ſtock, whoſe Edges are made ſharp for that Purpoſe, and may be ſet wider or narrower at Pleaſure: It is put into the Hole along with an half-round Piece of Wood, the lower End of the Stock being ſet faſt in a Vice: The whole Seed-box (for it muſt always be ſcrewed together before it is bored), being put on the End of the Stock (made taper a little way for entering), is turn'd round it by a long wooden Spanner, which hath a Notch in the middle of it, to receive the whole Seed-box, in order to bore it by turning it round upon the Stock.

The Braſs ought to be of the beſt Sort, which will be eaſy to file, and yet not mix with baſer Metal.

The Seed-boxes may be caſt whole by theſe Moulds; but I prefer thoſe that are ſcrew'd together, for ſeveral Reaſons, which I have not time now to write.

There is a Turnep Seed-box come to my Hands that was made by Pretenders; I wiſh it is the only one made in the ſame manner; for it is uſeleſs; the Notches in the Spindle are much ſhorter than the Breadth of the Mortiſe; at each End of the Notches is a deep Chanel (as deep as the Bottom of the Notches) quite round the Spindle, inſtead of a Mark, which ſhould be but juſt viſible for cutting the Notches; and inſtead of a tender Steel Spring, there is a ſtrong Piece of Iron without Elaſticity. By means of this Iron, the Machine grinds the Seed, inſtead of drilling it.

What I ſhall here add concerning the Wheat-drill, is ſome Alterations in *Fig.* 21. of *Plate* 4. *viz.* The fore Share and Sheat muſt be left out for drilling Wheat, no more middle Rows being uſed. And the Two Beams B B in the Plough, *Fig.* 1. muſt be ſet to make Chanels Ten Inches aſunder. And the double Hopper, *Fig.* 15. muſt be ſet nearer together, ſo as the Seed may fall into the middle of the Funnels of the Beams.

Tho' there is no Neceſſity of Marking-wheels for guiding the Drill-horſe upon Ridges; yet they are very uſeful for holding the Drill ſteady, and to prevent its tottering, which without the Marking-wheels, and the fore Hopper, it is apt to do, when the Shares ſtand ſo near together as Ten Inches; and on a narrow Ridge one of the hinder Wheels might run off to the Furrow, and draw the Shares after it, if the Drill were not kept ſteady by the Marking-wheels, and by their Hopper, which takes hold of the ſingle Standard by *Fig.* 22. as is ſeen in *Fig.* 21. in *Plate* 4. But there ſhould not be ſo much room in it on each Side of the Standard, leſt the Plough by that means ſhould have too much room to totter, now the Shares are ſo near together.

The Marking-wheels muſt be ſet at the Diſtance of the Breadth of Two Ridges, which, as we now make them, is about Nine Feet and an half from Wheel to Wheel.

The Braſs Box may be taken out of the fore Hopper: And tho' that Hopper be of no Uſe to the double Row, except as is aboveſaid; yet if there ſhould be Occaſion to preſs the Marking-wheels deeper into the Ground for keeping the Plough the more ſteady in its Courſe, it may be uſefully fill'd with Earth, or other Matter, ſufficient for that Purpoſe. And beſides, it may ſerve to plant Three Rows of St. Foin, when the fore Share and Sheat are put in, and the Beams and hinder Hopper ſet a Foot or Eighteen Inches wider, and the Marking-wheels at their due Diſtance, as is directed in the Eſſay. Thus the ſame Drill may plant Wheat and St. Foin.

A Drill for the double Rows might be made with a ſingle hinder Hopper, inſtead of the double one. And there is a Contrivance to ſupply the Uſe of the fore Hopper for keeping the Plough ſteady, and more eaſy to make than that Hopper; but this cannot be deſcribed by Words without Cuts.

The Lime wherewith the brined Wheat is dried, receiving ſome of the Salts from the Brine, will ſtick in the Notches of the Spindle; yet never makes any Stoppage to their Delivery of the Seed; but every Year we clean the Notches from the Lime with a Chiſſel; and, if it were done oftener, it would not be amiſs.

There is an Accident that may poſſibly happen, but never to a careful Driller; *viz.* a large Clod may ſome way be thrown into a Funnel of the Beam of the Plough, either by a Wheel, or by the Paddle that cleanſes the Sheats from the Dirt that ſticks to them when the Earth is wet. This may ſtop the Wheat from falling out of the Funnel into the Trunk; and then, ſo far as the Plough goes thus ſtopp'd, the Chanel will have no Seed in it; but the Driller that follows may take it out immediately, which if he ſhould neglect to do for never ſo little a Diſtance, he ought to ſtop the Plough whilſt he ſupplies the Chanel with Seed from his Hand as far as it is empty. When there is any Danger of this, as in very rough cloddy Ground, it is beſt to take off the Drill-harrow, to the end that the Chanel may lie open for receiving the Seed from the Hand. But if the Ends of the Hopper reach below the Funnels, and they are otherwiſe defended, as they may be, this Accident can never happen.

When the Drill-harrow is taken off, the beſt way for taking up the Plough to turn it, is to bore a Hole of about half an Inch Diameter in the End of each Beam behind the Funnels, and faſten a Withe into theſe Holes; by which Withe the Driller very conveniently takes hold with one Hand, and lifts up the Plough, laying his other Hand on the Hopper to keep it ſteady. This Method of taking up the Plough hath been often uſed for the Wheat-drill, and for the Turnep-drill; and in the latter the Hole in the one Beam holds the Withe as well as do the Two Holes in the former.

There are new Editions of ſome of theſe Engines, which cannot be fully deſcrib'd without more *Plates*; but ſince thoſe already deſcrib'd are found by Experience to be ſufficient for the Purpoſes they were deſign'd for, new Editions of them are not neceſſary, tho' convenient in many reſpects.

Reaſon will eaſily make Additions to the Inſtruments when they are neceſſary; as when more than one Braſs Spindle is to be turn'd by one or each Wheel for planting Clover amongſt Barley after it is come up. 'Tis done by a very light Plough, drawn by a Man: It plants Four Rows at once Eight Inches aſunder: The Shares are very ſhort and narrow, and ſo are the Sheats and Trunks. 'Tis not difficult to put on a Crank at the other End of the Braſs Spindle, in the ſame manner that the Handle that winds up a Jack is put on, and to faſten it at the Hole at I in *Fig.* 5. of *Plate* 2. This Crank muſt at its firſt turning, before it turns up towards the Letter H, of the ſame *Fig.* be long enough to reach to within an Inch of the Fork of the Second Spindle. Thus each Wheel may turn ſeveral Spindles, and then this Drill may plant many Rows of Seeds at once.

When you plant Rows nearer together than Eight Inches, it is beſt that the Plough have Two Ranks of Shares and Hoppers, elſe the Earth may be driven before the Shares; but with Two Ranks of them, they will not be more apt to drive the Earth before them in making Rows at Four Inches aſunder, than at Eight, when there is only a ſingle Rank of Shares.

But I think this near Diſtance of Four Inches cannot be proper for any ſort of Seeds, except Flax-ſeed; and even for that Seed not neceſſary. If the Land be made fine, a ſingle Rank of Shares will go very well to plant Rows at Seven Inches aſunder.

I had formerly a Drill-Plough for drilling acroſs very high round Ridges for Hand-hoeing, where Horſe-hoeing is impracticable: It had no Limbers; but it had little Ground-wriſts to make open Chanels, and had Handles behind it, whereby the Driller rais'd up the Tail of the Plough, when it was paſſing the Summit of the Ridge. There were neither Funnels nor Trunks; for theſe would hinder the Seed from falling into the Chanels, both by the Plough's going up and down the Ridge. The Hopper was drawn by the Plough in ſuch a manner, that in paſſing all Parts of the Ridge the Wheels were not raiſed from the Ground: The Chanels were equally ſupplied with Seed throughout: It planted Four Rows at once, at a Foot aſunder. I uſed this Drill-Plough 30 Years ago in *Oxfordſhire*: I have no ſuch Ridges here, nor conſequently any Occaſion of ſuch an Inſtrument; and did not make Cuts of it, becauſe it is not uſeful for Horſe-hoeing. I only mention it here for the Benefit of thoſe who have a mind to plant ſuch Ridges regularly with an Engine: I hope their own Reaſon will enable them to contrive ſuch a Plough, eſpecially now they have the manner of making the Drill, Hopper, *&c.* ſhewn to them.

I have made a very material Addition to the Hoe-Plough, of *Plate* 6. *viz.* At the fore End of the Beam *Fig.* 2. is the Hole I, by which alone let the Plough be drawn, leaving out the Hole H; inſtead of the Hole G make a Mortiſe, Three or Four Inches long, and as broad as the Thickneſs of the Iron Pin, the End and Nut of which are ſeen at C, in *Fig.* 1. This Pin ſhould be more than half an Inch Diameter, and ſquare at that End that goes into the Mortiſe; let the hinder End of the Mortiſe juſt appear behind the Plank, when the Beam is at right Angles with it.

By means of this Mortiſe there may be many more Holes through the Plank without Danger of ſplitting into one another the Holes in the Beam, which muſt anſwer thoſe in the Plank.

Draw many Lines from the Middle of the foremoſt Hole of the Plank to the hinder Edge of it, at (ſuppoſe) a quarter of an Inch from one another there; and then bore a Hole in that Part of each Line that is leaſt apt to break into the next Hole to it.

Every Syſtem of Holes in the Plank will have like Benefit of being increaſed in their Number by the Convenience of this Mortiſe; without which it is impoſſible to have ſo great Variety of turning the Point of the Share to make the Share go parallel to the Horſe-path.

The Board deſcrib'd in *p.* 403. we now uſe very ſeldom in Hoeing of Wheat.

Explanation of Plate VII.

FIG. 1. ſhews the Plank and the Harrow of the lateſt and beſt Drill-plough, moſt ſimple, and accommodated to the preſent Practice of planting double Rows.

A is the Plank, with all its Mortiſes and Holes; *b* is the Mortiſe into which the Tenon of the fore Sheat of the Drill-plough, for planting treble Rows, was faſtened; *d* is the ſquare Hole for receiving the Seed from a Hole of the ſame Shape and Size in the Bottom of the Funnel.

When the Sheat is taken out of the Mortiſe *b*, and another Sheat is made exactly the ſame with that, place them in the Mortiſes *a a*, and make the Two ſquare Holes *c c* behind them, for their Funnels to ſtand on. Make the Mortiſe *e*, which is to hold the ſingle Standard that is to hold up the fore Hopper in the treble Drill, and in this to guide the Wheels alſo, inſtead of Wreaths, that in the treble Drill are put on the Spindle, bearing againſt the Inſides of the double Standards; for in this the Shares being but Ten Inches aſunder, and at ſuch a Diſtance from each of the Wheels, that neither of them doth by riſing lift up a Share perceptibly; but if the Shares were wide aſunder, or there were more of them reaching nearer to the Ends of the Plank, a Wheel might riſe up, and lift a Share out of the Ground, if guided by the ſingle Standard and Hopper, as in this. The ſingle Standard is ſhewn in *Plate* 4. *Fig.* 10. but this has no Fork at its Bottom, as that has. This has only a ſingle Tenon, and is ſhoulder'd before, behind, and on each Side, to hold it the more firm and ſteady, when tightly pinned down by Two Pins underneath the Plank. The Dimenſions of this Standard are the ſame with thoſe of the other; but the Shoulders muſt not increaſe the Thickneſs of the Standard any higher than the Tops of the Funnels.

The Four other ſquare Holes, *viz.* *f* with another behind it, and *g* with one before it, are for the double Standards, which are to be well ſhoulder'd, or brac'd on the Side of each that is next to the End of the Plank, and on the Outſide. There is no need of Shoulder or Brace on the Sides where the Spindle is placed, or on the Side next to the Middle of the Plank.

The Four round Holes *h i k l* are thoſe thro' which the Four Pins paſs that hold on the Limbers, and the Piece A, in *Fig.* 2. and the other of the ſame Sort in *Fig.* 4.

Fig. 2. and 4. ſhew how the Harrow's Leg B is held to the Piece A, by the Pin C. The Letters *a b* ſhew the Holes through which the Pins do paſs to ſcrew the Piece A up to the Plank, and the Limbers for guiding the Harrow. This Piece A is ſomewhat longer than the Breadth of the Plank; it is about Two Inches thick, and Two and an half in Depth. The Pin *Fig.* 3. goes through this Piece near the Bottom of its fore End, whereby the Harrow-tines have the more room to riſe up, without being held down by the Legs preſſing againſt the Plank.

Fig. 3. is the Pin C, of *Fig.* 2. *a* is its Head, *b* its round Part, whereon the Harrow moves; *c* is its ſquare Part, that prevents its turning, which by the Motion of the Harrow would unſcrew the Nut *d*, and cauſe it to come off of the Screw *e*, and be loſt.

The Harrow is alſo ſhewn in *Fig.* 1. as it is guided by the Pieces before deſcribed: B is its Head, that holds the Tines D D, drawn by the Legs C C. Tho' theſe Legs *in Plano* ſeem in their Middle to crook ſideways, yet when out of Perſpective, their Middles crook only downwards; which is to give the greater Length to the Tines, and the more room for them to move up.

Fig. 5. is the Spindle in Three Parts: A is the middle Part, wherein are the Notches *b b*. This is beſt to be of Oak, or ſome other hard Wood, in which the Edges of the Notches are leſs apt to wear than in ſofter Wood; but I have had a Set that have laſted the Drilling of 120 Acres, when made of Aſh. B and C are the other Two Parts: D and E are their Ends, whereon the Wheels are put. The Holes *b b b b*, and the ſame in the other End under the Letter E, are for ſetting the Wheels at different Diſtances, in order for making new Notches, or for different-ſized Ridges: The Wheels are held in their Places by long Nails put through ſome of theſe Holes, and clench'd upon the Iron Stock-bonds to prevent their falling out. Theſe Ends B and C need not be cut to a Square; except juſt enough to prevent the Wheels from turning on the Spindle.

Theſe Three Parts are grafted together by Help of the hollow Cylinder *Fig*. 6. which, being put on upon the Joint *f*, of the Spindle *Fig*. 5. holds the Parts A and B together by the Two Pins *a a*, paſſing through the Cylinder near its Ends, and through the Holes *k* and *g*.

This Joint may be in another manner; *viz*. One Part of the Spindle may enter into the other by cutting it to a ſquare Peg of an Inch long, and 3 4ths Diameter, entering an Hole that fits it, at the End of the other Part.

Theſe Pins will be beſt to have Screws at their Ends with Nuts to them; and then they need not be ſo tight in the Holes, and may be the more eaſily taken out, when the Part B is to be taken off for avoiding Obſtructions in drilling an outſide Ridge.

The Cylinder is a Foot long, and about half an Inch thick, bound with an Iron Ferrel at each End; and if there were another in the Middle, it might be the ſtronger.

Place the Cylinder on the Outſide of the Spindle, the Joint *f* being exactly againſt the Middle of the Cylinder; and mark at each End of it, in order to ſee when it is in its right Place; and after it is put on and pinned, mark likewiſe on the Spindle the exact Places of the Holes, for the more eaſy finding them every time the Cylinder is put on.

Another Cylinder muſt be on the Joint *c*, held together by Pins paſſing thro' the Holes *i* and *d*, in the ſame manner, and for the ſame Purpoſe, as the other Joint already deſcrib'd.

The Spindle ought to be of equal Diameter with the Bore of the Seed-boxes, thro' which it is to paſs; but this I find, needs not be quite an Inch and 3 4ths; it may want an 8th of it, even in this long Spindle.

Fig. 7. is one of the Pins which hold the Cylinder in its Place, as has been ſaid; *a* is its Head; *b* the Stalk, which would be better to be a Screw at its lower End, whereon to ſcrew a Nut; but then the Stalk muſt be ſquare at the Head.

Fig. 8. is a Sheat with its Trunk and Share of the Drill-plough, which has been deſcribed in *Plates* 4. and 5. but the Shape of the Share, as it riſes at the Socket, is more plainly ſeen in this Figure.

Fig. 9. is the whole Wheat-drill, which at preſent I uſe for planting the double Row. A is the Hopper, riſing and ſinking on the ſingle Standard B, which holds it up. C is the thing like the Carrier of a Latch, deſcribed by *Fig.* 22. in *Plate* 4. I need ſay no more for deſcribing this Drill, than to ſhew how it differs from that deſcribed in *Plate* 4. *viz.* This Hopper has Two of theſe Carriers, the one near its Top, like the other; and another near its Bottom, which keeps the Plough from riſing at either End, without the riſing of either End of the Hopper, which is no Inconvenience here; becauſe the Two Shares, being but Ten Inches aſunder, are almoſt the ſame as one; ſo that at the Diſtance the Wheels ſtand from each other, the riſing of one Wheel doth not lift up the Share that is next to it perceptibly; as it would do if the Shares were farther aſunder, or the Wheels nearer together.

This Hopper holds twice as much Seed as the ſingle fore Hopper did, *viz.* half a Buſhel; and is divided into Two equal Parts by the Partition *e*, whereby the Driller ſees whether the Seed is diſcharg'd equally; and if he perceives that one Part of the Hopper runs out faſter than the other, he muſt adjuſt them by the Setting-ſcrews.

The Funnels *a a*, which receive the Seed from the Hopper, and convey it down into the Trunks *c c*, appear under the Hopper, as doth alſo Part of the Hole *d*, whereon the Funnel ſtood when the fore Hopper was ſingle. D ſhews the Cylinder upon the grafted Spindle at one End, as F ſhews where the other End with its Cylinder and Wheel is taken off. The Ends of the Piece A, which guide the Harrow, appear behind the Plank at *f f*. At *g* in the Harrow-head is a Hole exactly in the Middle between the Tines, for tying on a Stone when the Harrow is too light for the Soil. *Note*, This Hole muſt follow exactly after the Middle of the Plank, *i. e.* between the Two Shares at an equal Diſtance from each.

Obſerve, that the Legs of this Harrow go thro' the Head on the Outſides of the Tines, as in the treble Drill they go thro' on the Inſide of the Tines. Inſtead of the wooden Tines, may be put in common Iron Tines of a proper Length.

The Two Hooks whereby the Plough is drawn are at *b b*. 'Tis beſt for the Ends of the Hooks to turn upwards, ſo that the Links of the Chain-traces, that are to be put on them, may not be apt to drop off. Take care that theſe Traces be of an equal Length, which may be eaſily made even by the Links that are put on theſe Hooks.

Note, The Links of the Piece of Chain, whereby the Plough is made to go deeper or ſhallower, may be very ſmall, and by no means in the Proportion they bear to the Limbers in the Cut. There need not be above Four or Five Links. If there be occaſion to raiſe or ſink the Limbers more than that Number will reach, the Cord may be tied longer or ſhorter on the other Limber. And when there is not the Convenience of Chain-traces, they may be ſupply'd by a few Iron Links at the Ends of Hempen Traces.

Fig. 10. is the Shape of a wooden Wreath, which (when the Shares ſtand wide aſunder, or when there are more than Two of them, ſo that they come nearer to the Ends of the Plank, this Wreath) is neceſſary to be put on the Spindle, the End *a* bearing againſt the Inſide of the double Standards, and the End *b* being towards the Hopper. 'Tis fixt to the Spindle by the Screw *c*, which ſhould not enter the Spindle above half an Inch deep. There may be another like Screw to enter in the ſame manner on the oppoſite Side of this Wreath. There muſt be in this caſe another Wreath the ſame of this to bear againſt the other double Standards. And when theſe Wreaths are uſed, the Hopper muſt have only the upper Carrier C; the lower one muſt be taken off. But in this our Drill for planting Wheat, no Wreaths muſt be on the Spindle, except thoſe at *b b*, which are to hold the Hopper from moving endways. And theſe may be of the Sort above deſcribed, the End *a* bearing againſt the Hopper.

Fig. 11. is the Beam of the Hoe-plough deſcrib'd in *Plate* VI. *Fig.* 2. with no other Alteration than leaving out the Hole H, and the prick'd Line between it and the Hole I; and changing the Hole G into a Mortiſe. The prick'd Line *a b* repreſents the hinder Edge of the Plank, behind which appears a very ſmall Part of a Mortiſe. See *p.* 415, 416.

Fig. 12. is the Plank, which is *Fig.* 3. in *Plate* VI. The Improvement of it in this Figure is deſcrib'd in *p.* 415, 416.

An Appendix *to Chap.* IX. *of* Wheat, *p.* 138. *containing* Memoranda *for the Practiſers of this* Huſbandry.

AT the Second Hoeing the Plough goes in the Furrow of the Firſt, making it deeper, and nearer to the Wheat. The Third Hoeing fills up this Furrow; and then, at the Fourth Hoeing, the Plough goes in the ſame Place as the Second, turning the Mould into the Interval. 'Tis remarkable that though the Furrows of the Second and Fourth Hoeings be deep, and near to the Rows, ſeeming to deprive the Wheat of the Mould which ſhould nouriſh it, whereby one would imagine, that theſe Furrows lying long open ſhould weaken or ſtarve it; yet it is juſt the contrary; for it grows the more vigorous: And it is the Obſervation of my Ploughmen, that they cannot at theſe Hoeings go too near to the Rows, unleſs the Plough ſhould tear out the Plants.

If I may preſume to aſſign the Cauſe of this ſurpriſing Effect, it is, in my Opinion, the following; *viz.*

Plate 7.

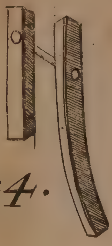


Fig: 4.

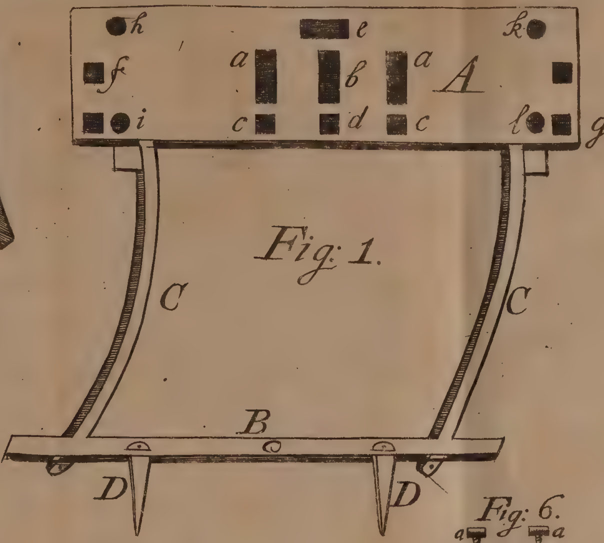


Fig: 1.

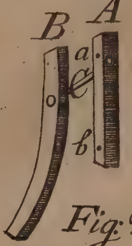


Fig: 2.

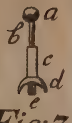


Fig: 3.

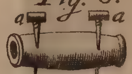


Fig: 6.

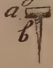


Fig: 7.

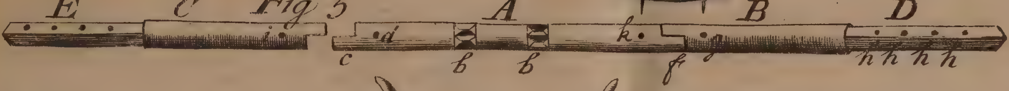


Fig 5

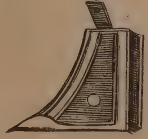


Fig: 8.

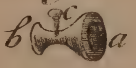


Fig: 10.

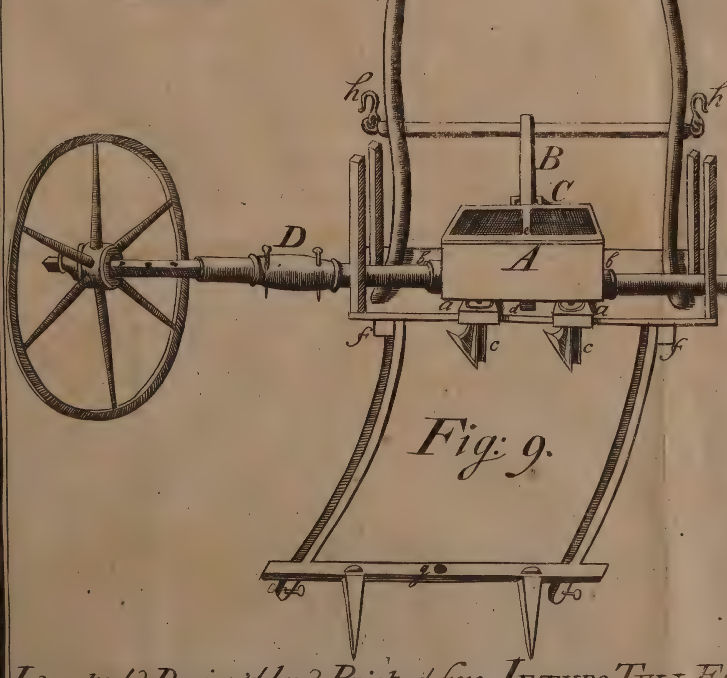


Fig: 9.

Fig: 12.

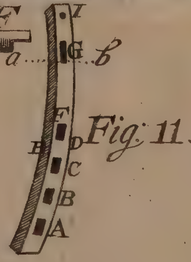


Fig: 11.

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This open Furrow has a double Surface of Earth, which by the *Nitre* of the contiguous *Atmoſphere*, is pulveriz'd to a great Degree of Minuteneſs near the Row. The Roots that the Plough cuts off on the perpendicular Side of the Furrow, ſend out new Fibres to receive the *Pabulum* from this new-made Paſture; and alſo Part of this ſuperfine Powder is continually falling down into the Bottom of the Furrow, and there gives a very quick Growth to thoſe Roots that are next it, and a quick Paſſage through it into the Earth of the Interval, where they take likewiſe the Benefit of the other Side of this pulveriz'd Furrow. When it is ſaid, that Air kills Roots, it muſt not be underſtood, that it kills a Plant, unleſs all, or almoſt all, its Root is expoſed to it, as it is not in this Caſe. Some think there are Roots that run horizontally below the Plough into the Interval; but of this I am not convinced.

'Tis not often that we hoe above Four times; and then the Furrow is turned towards the Row at the Third time only.

There being no Danger from theſe Furrows lying long open, we are not confined to any preciſe Diſtance between the times of Hoeing, for which we need only regard the Weather, the Weeds, and our own Convenience of Opportunity and Leiſure.

'Tis an Advantage when theſe Furrows lie open on each Side of the double Row till Harveſt; for then there need only Two Furrows to be plowed on a Ridge to throw down the Partition in order for planting the next Crop; but if at the laſt Hoeing the Furrows are turned towards the Row, they muſt be plow'd back again after Harveſt before the Partition can be plow'd: This requires double the time of the other; and the ſooner the Partitions are plowed, the more time they will have to be pulveriz'd before they are replanted. Indeed this Advantage is only when the Rows are to be planted where they were the Year before; for this is rather a Diſadvantage when they are to be planted in the Intervals. Whether theſe Furrows lying long open next the Rows in very hot dry Climates may be prejudicial, cannot be known, but by Trials.

As from the external Superficies of an Acre of Paſture on a rich Soil, Animals take more *Pabulum* than of an Acre on a poor Soil; ſo Vegetables take more *Pabulum* from the internal Superficies of a rich Acre than of a poor one; the Pulveration, or Superficies of Parts, being equal. *See p.* 44, 45. From whence there is no Encouragement for making Trials on very poor Land.

'Tis no great Matter whether the Rows are drilled on the Partitions, or the Intervals; for the Crops of a Field, Four Years ſucceſſively drilled on the Partitions, were very good. After the Partitions had been plowed, and lain open till the Weather made them pulverizable by the Harrows, and then turned together by Furrows larger than thoſe which opened them, much Earth of the Intervals was mixt with them. This is the ſtrongeſt and loweſt Ground I have; and if there ſhould be much wet Weather after Harveſt, it is ſo long in drying, that we take the firſt Opportunity the Weather allows for planting the Wheat, which is generally done in the above manner, becauſe it is the ſhorteſt; but, without ſome ſuch Reaſon to the contrary, I prefer planting the Rows on the precedent Intervals.

My Field, whereon is now the Thirteenth Crop of Wheat, has ſhewn that the Rows may ſucceſsfully ſtand upon any Part of the Ground. The Ridges of this Field were for the Twelfth Crop, changed from Six Feet to Four Feet Six Inches: In order for this Alteration, the Ridges were plowed down, and the whole Field was plow'd croſs-ways of the Ridges for making them level; and then the next Ridges were laid out the ſame way as the former, but One Foot Four Inches narrower; and the double Rows drilled on their Tops, whereby of conſequence there muſt be ſome Rows ſtanding on every Part of the Ground, both on the former Partitions, and on every Part of the Intervals: Notwithſtanding this, there was no manner of Difference in the Goodneſs of the Rows, and the whole Field was in every Part of it equal, and the beſt, I believe, that ever grew on it. It has now the Thirteenth Crop, likely to be very good, tho' the Land was not plow'd croſs-ways.

The proper Times for Plowings and Hoeings depending upon the Weather, and other Circumſtances, cannot be directed but by the Reaſon and Experience of the Practiſer, as has been ſaid.

The Number of Ridges being increaſed, as their Breadth is now diminiſh'd, occaſions ſomewhat the more Plough-work; we likewiſe uſe more Hand-work than formerly; but the Profit of this increaſed Labour is more than double to the Expence of it.

The Decline of the Woolen Manufacture furniſhes us at this time with Plenty of Hand-hoers and Weeders; becauſe they can earn much more by working in the Field than by Spinning at home.

'Tis better to make Fifteen Ridges on an Acre, than to leave any Earth unmoved by the Hoe-plough in the Middle of the Intervals; but when Ploughmen, by Practice, underſtand well to uſe the Hoe-plough, they will plow the Intervals clean, tho' the Ridges are only Fourteen on an Acre.

Bearded Wheat is in this Country called *Cone*, and that which has no Beard *Lammas*. I obſerved formerly the Bread of *White-cone* had a little yellowiſh Caſt, which I now ſuſpect was from the Mill-ſtones; for I have ſeen it be very white theſe many Years, ſince the Millers know better how to grind this Wheat. Cone-wheat Weſtwards yields Six-pence a Buſhel more than *Lammas*; but towards *London* the contrary.

The Reaſons why a whole Field of Wheat doth not produce a Crop equal in proportion to a Yard or Perch cut, rubb'd out, and weigh'd immediately upon the

Spot, may be, becauſe the Grain of the Field lying to ſweat in the Mow, loſes conſiderably of its Weight and Meaſure. There is alſo ſome loſt in the Field by Reapers, and by Leaſers; and ſome is by Threſhers thrown out of the Barn; and ſome of them are found to have Contrivances to carry home with them at Night, Part of the Wheat they threſh in the Day. I ſay nothing of thoſe Thieves, who in Harveſt rob the Field in the Dark; tho' they are not very uncommon.

I miſſed of making my propoſed Experiment of the ſingle Row, after I had prepared for it by plowing out one of the double in ſeveral Places for that Purpoſe; but, in the Hurry of Harveſt, they were cut together with the reſt, without making any Trial; as ſhould have been made, if my Illneſs had not prevented my Attendance in the Field at the time of Reaping.

The Practice and Inſtruments that are left off for better in their room, as the Quadruple and Treble Rows, *&c.* are ſtill uſeful to be ſhewn, in order to deter others from going into an inferior Method that is now exploded; for ſome might think it an Improvement of the double Rows, *&c.* by their own Invention, if they ſhould not know it had been already tried.

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